MINNESOTA POLLUTION CONTROL AGENCY

National Pollutant Discharge Elimination System /State Disposal System (NPDES/SDS) Permit Program Fact Sheet

Permittee	Facility Name	Permit Number: MN0071013
Poly Met Mining, Inc. P.O. Box 475 Hoyt Lakes, MN 55750	NorthMet Project 6500 County Road 666 Hoyt Lakes, MN 55750	

Current Permit Expiration: Not Applicable

Public Comment Period Begins: January 31, 2018
Period Ends: March 16, 2018

Receiving Waters:

- Wetlands in the headwater area of Unnamed Creek Class 2D, 3D, 4C, 5, 6)
- Wetlands in the headwater area of Trimble Creek (Class 2D, 3D, 4C, 5, 6)
- Second Creek (Class 2B, 3C, 4A, 4B, 5, 6)

Proposed Action: Permit Issuance

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Purpose and Participation

Applicable Statutes
This fact sheet has been prepared according to the Title 40 Federal Code of Regulations (CFR) 124.8 and 124.56 and Minn. R. 7001.0100, Subp. 3 for a draft NPDES/SDS permit to construct and/or operate wastewater treatment facilities and to discharge into waters of the State of Minnesota.

Purpose
This fact sheet outlines the principal issues related to the preparation of the draft permit and documents the decisions that were made in the determination of the effluent limitations and conditions of this permit.

Public Participation
The public was afforded the opportunity to submit written comments on the terms of the draft permit or on the Commissioner's preliminary determination. Written comments were required to include the following:

1. A statement of interest in the permit application or the draft permit.
2. A statement of the action the Minnesota Pollution Control Agency (MPCA) should take, including specific references to sections of the draft permit that should be changed.
3. The reasons supporting the position, stated with sufficient specificity as to allow the Commissioner to investigate the merits of the position.

Public informational meetings on the draft NPDES/SDS permit were held on February 7, 2018, in Aurora, MN and February 8, 2018, in Duluth, MN. A public informational meeting is an informal meeting which the MPCA may hold to help clarify and resolve issues. For more information on the public informational meetings, visit https://www.pca.state.mn.us/public-notices.

In addition, the public was afforded the opportunity to submit a petition for a contested case hearing. A contested case hearing is a formal hearing before an administrative law judge. The petition requesting a contested case hearing must include a statement of reasons or proposed findings supporting the MPCA decision to hold a contested case hearing pursuant to the criteria identified in Minn. R. 7000.1900, subp. 1, a statement of the issues proposed to be addressed by a contested case hearing, and the specific relief requested. To the extent known, the petition should include a proposed list of witnesses to be presented at the hearing, a proposed list of publications, references or studies to be introduced at the hearing, and an estimate of time required to present the matter at the hearing.

All comments, requests, and petitions were required to be submitted during the public comment period identified on page 1 of this notice. All written comments, requests, and petitions received during the public comment period were considered in the final decisions regarding the permit. If the MPCA does not receive any written comments, requests, or petitions during the public comment period, the Commissioner or other MPCA staff as authorized by the Commissioner will make the final decision concerning the draft permit.

The permit will be issued if the MPCA determines that the proposed Permittee or Permittees will, with respect to the facility or activity to be permitted, comply or undertake a schedule to achieve compliance with all applicable state and federal pollution control statutes and rules administered by the MPCA and the conditions of the permit and that all applicable requirements of Minn. Stat. ch. 116D and the rules promulgated thereunder have been fulfilled.

More detail on all requirements placed on the facility may be found in the Permit document.

Facility Overview

Poly Met Mining, Inc. (PolyMet) proposes to develop a copper-nickel-platinum-group elements (PGE) mine and associated processing facilities. The proposed mine and processing facilities, known as the NorthMet Project (Project), are described in detail in the NPDES/SDS Permit Application dated July 2016 and updated in October 2017. The Project is located south of the city of Babbitt and north of the city of Hoyt Lakes in St. Louis County, Minnesota, as shown on Figure 1.

The Project consists of the Mine Site, the Plant Site, and the Transportation and Utility Corridors that connect them. The Mine Site is a relatively undisturbed site that will be developed into an open pit mine and is located approximately six miles south of the city of Babbitt and two miles south of the Northshore Mining Company's active, open pit taconite mine (known as Northshore Mining's Peter Mitchell Mine). The Plant Site is located at the former LTV Steel Mining Company (LTVSMC) / Cliffs Erie, LLC (Cliffs Erie) taconite processing facility located approximately six miles north of the city of Hoyt Lakes and will include refurbished and new ore processing and waste disposal facilities. The Plant Site includes the Colby Lake Corridor, which contains an existing pipeline that will be refurbished as necessary and will supply water from Colby Lake to the Plant Site. The Mine Site and the Plant Site are connected by approximately 7- to 8-mile-long Transportation and Utility Corridors, which will include new and upgraded infrastructure to link activities at the Mine Site and Plant Site. Figures 2, 4 and 6 show the Project's currently planned configurations at full build-out in approximately Mine Year 11. Figures 3, 5 and 7 show the Project's footprint overlain on USGS topographic maps.

The Project is located in:

- Sections 1, 2, 3, 4, 9, 10, 11, 12, 15, 16, 17, and 18 of T59N, R13W;
- Sections 2, 3, 4, 5, 8, 9, 10, 11, 13, 14, 15, 16, 17, 23, and 24 of T59N, R14W; and
- Sections 32, 33, and 34 of T60N, R14W.

Maps of Permitted Facility

Figure 1 - Location of Permitted Facility: Plant Site, Mine Site, and Transportation & Utility Corridor

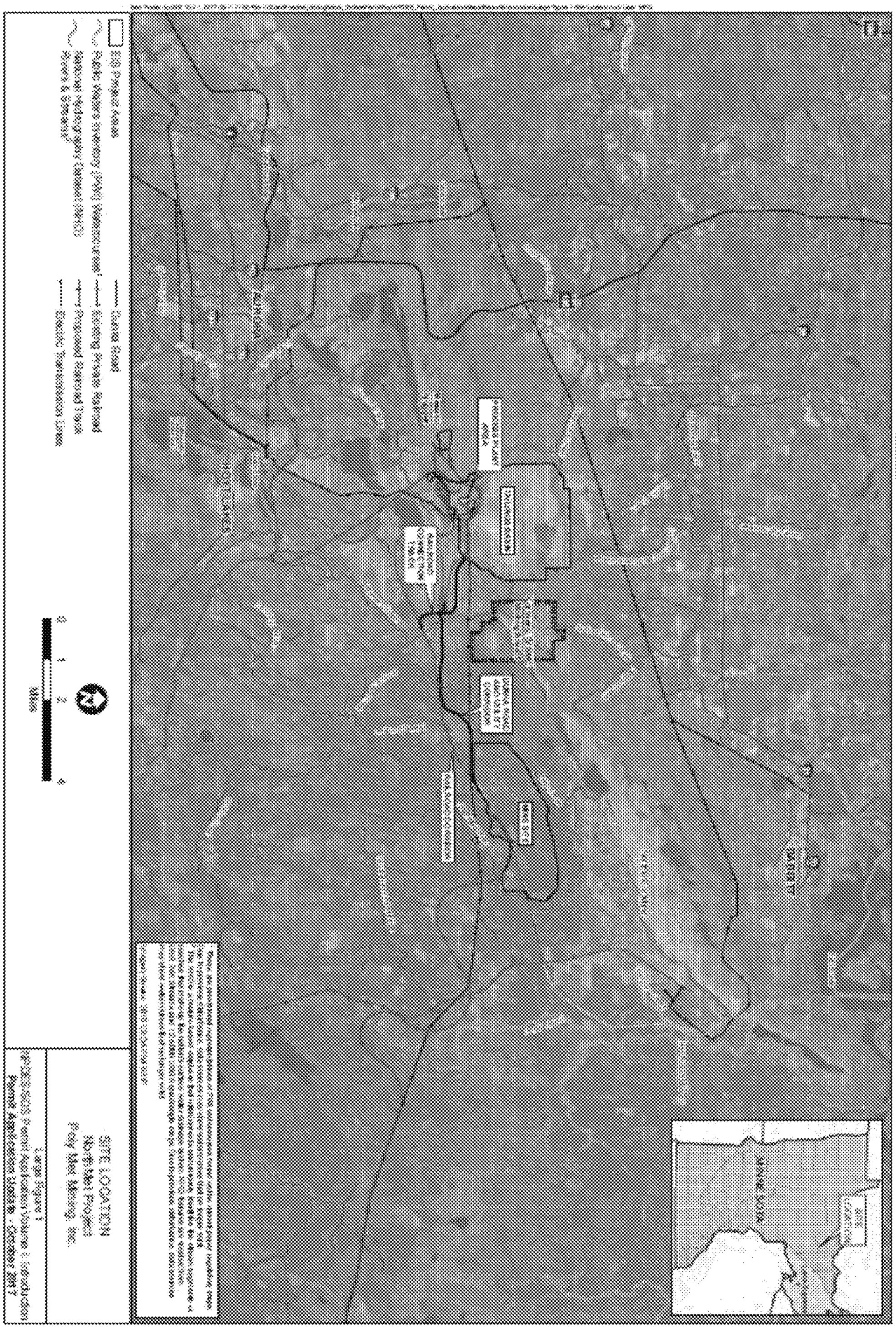


Figure 2 - Project Layout of Permitted Facility: Full Buildout at Approximately Mine Year 11

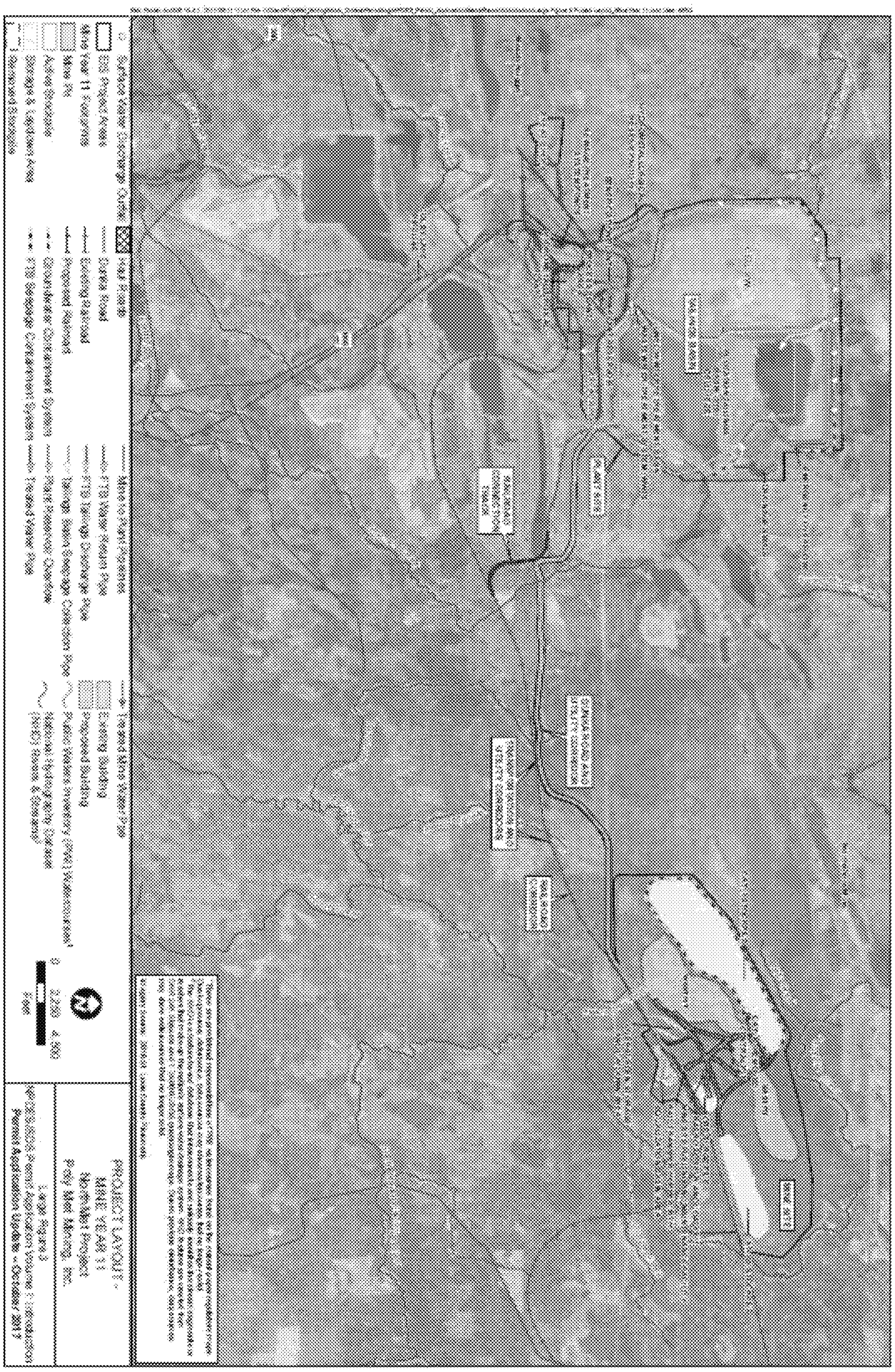


Figure 3 - Mine Site Location Map

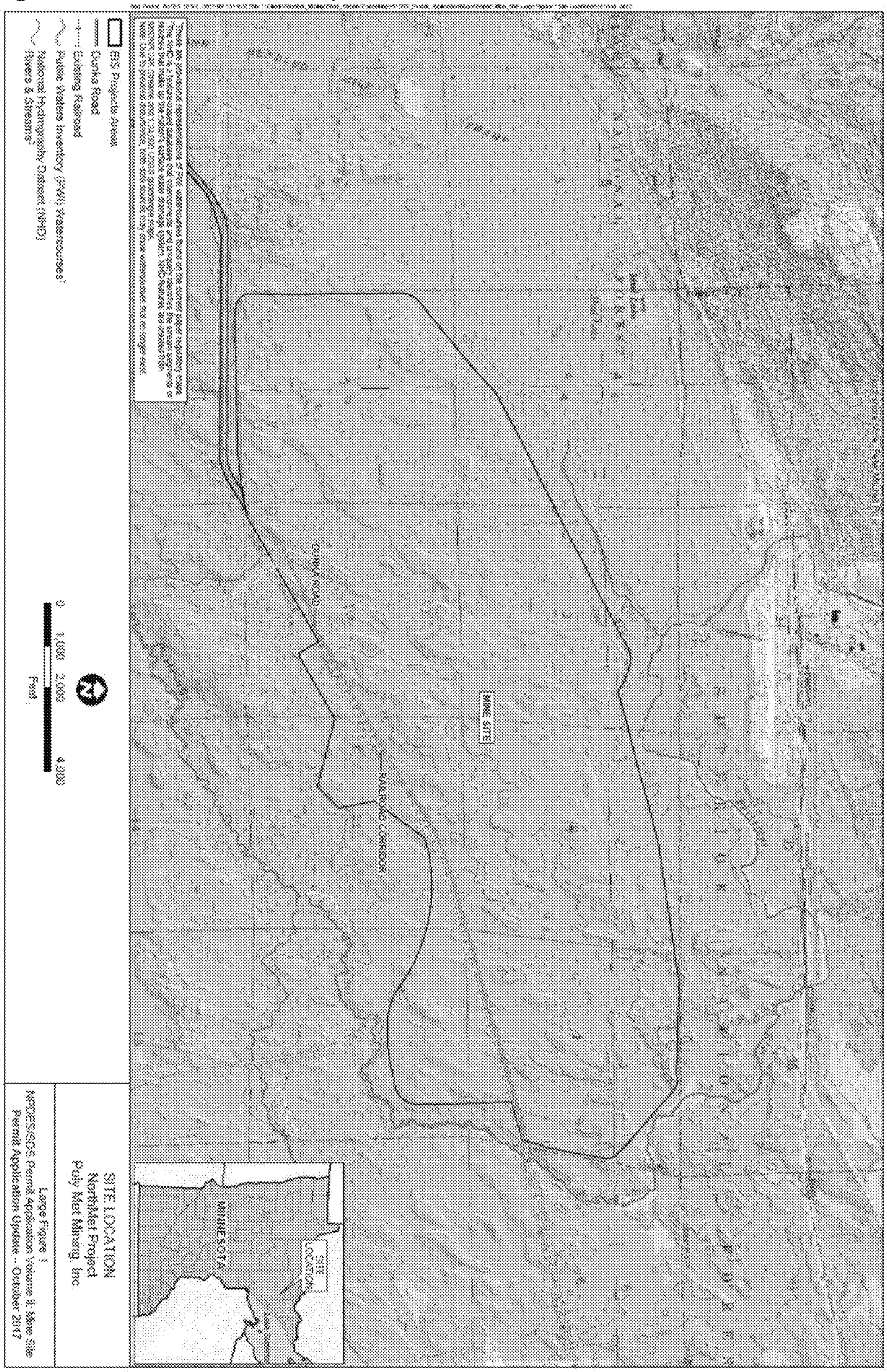


Figure 4 – Mine Site Layout: Full Buildout at Approximately Mine Year 11

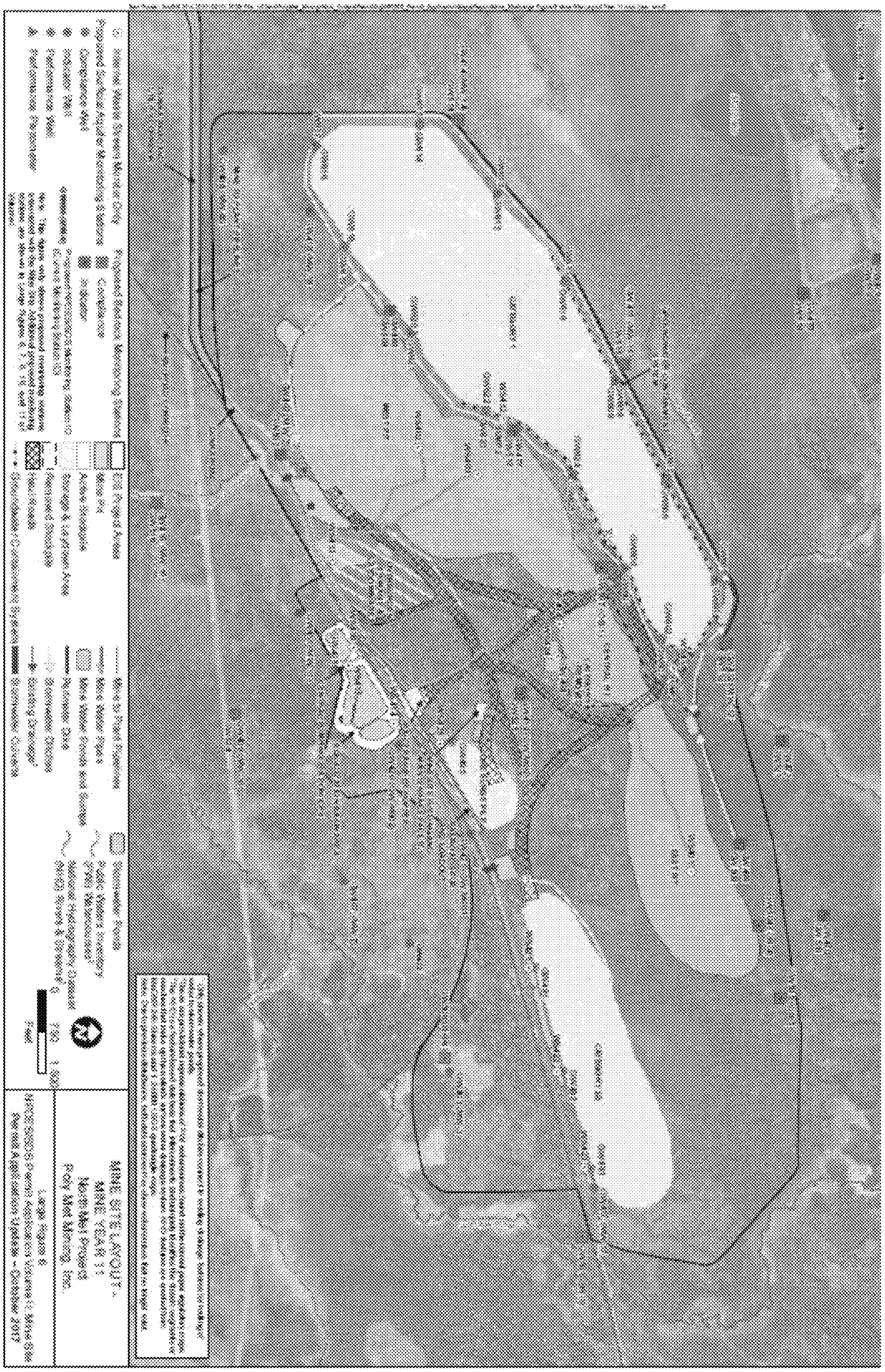


Figure 5 - Plant Site Map

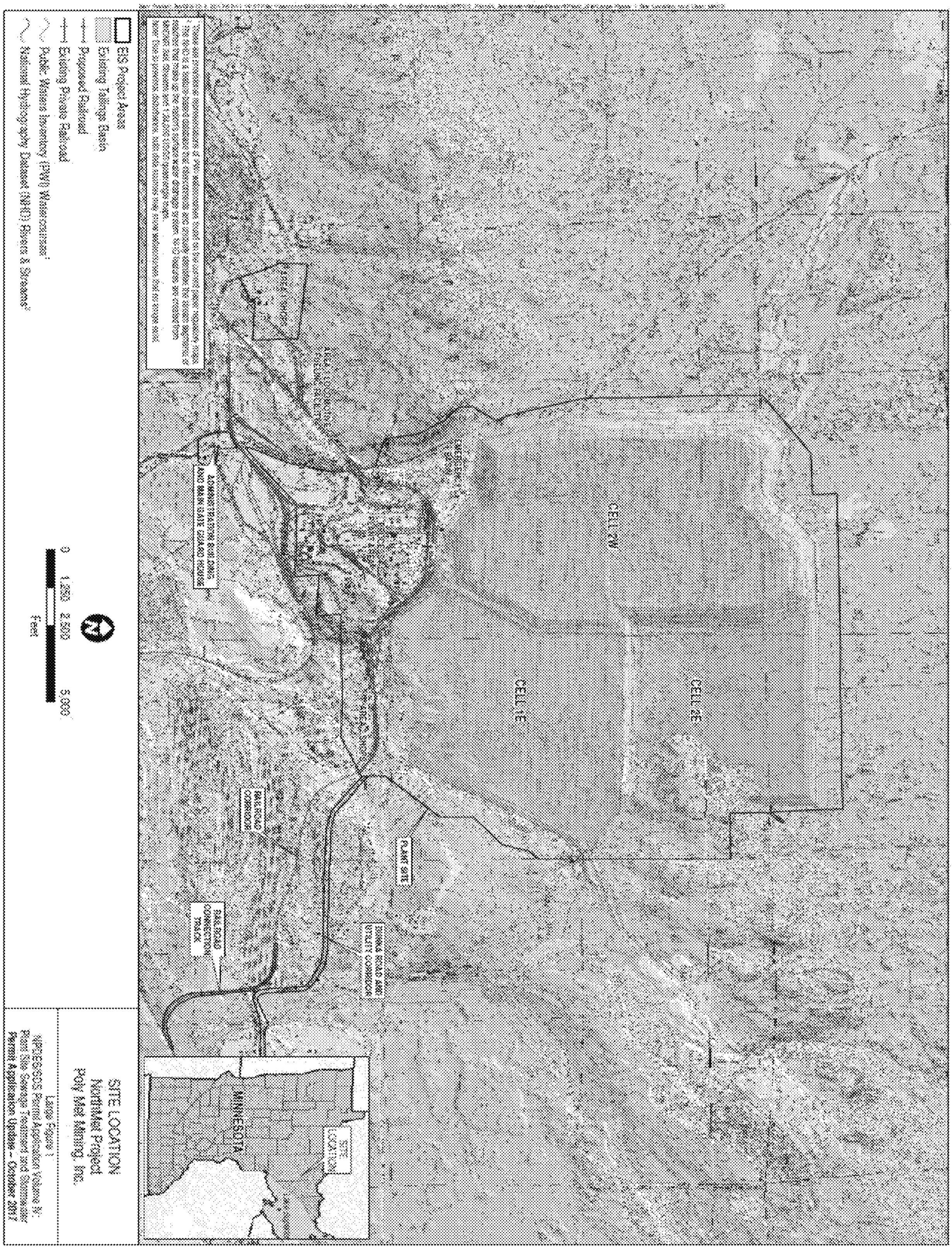


Figure 6 - Plant Site Layout: Tailings Basin & Hydrometallurgical Residue Facility at Approximately Mine Year 20

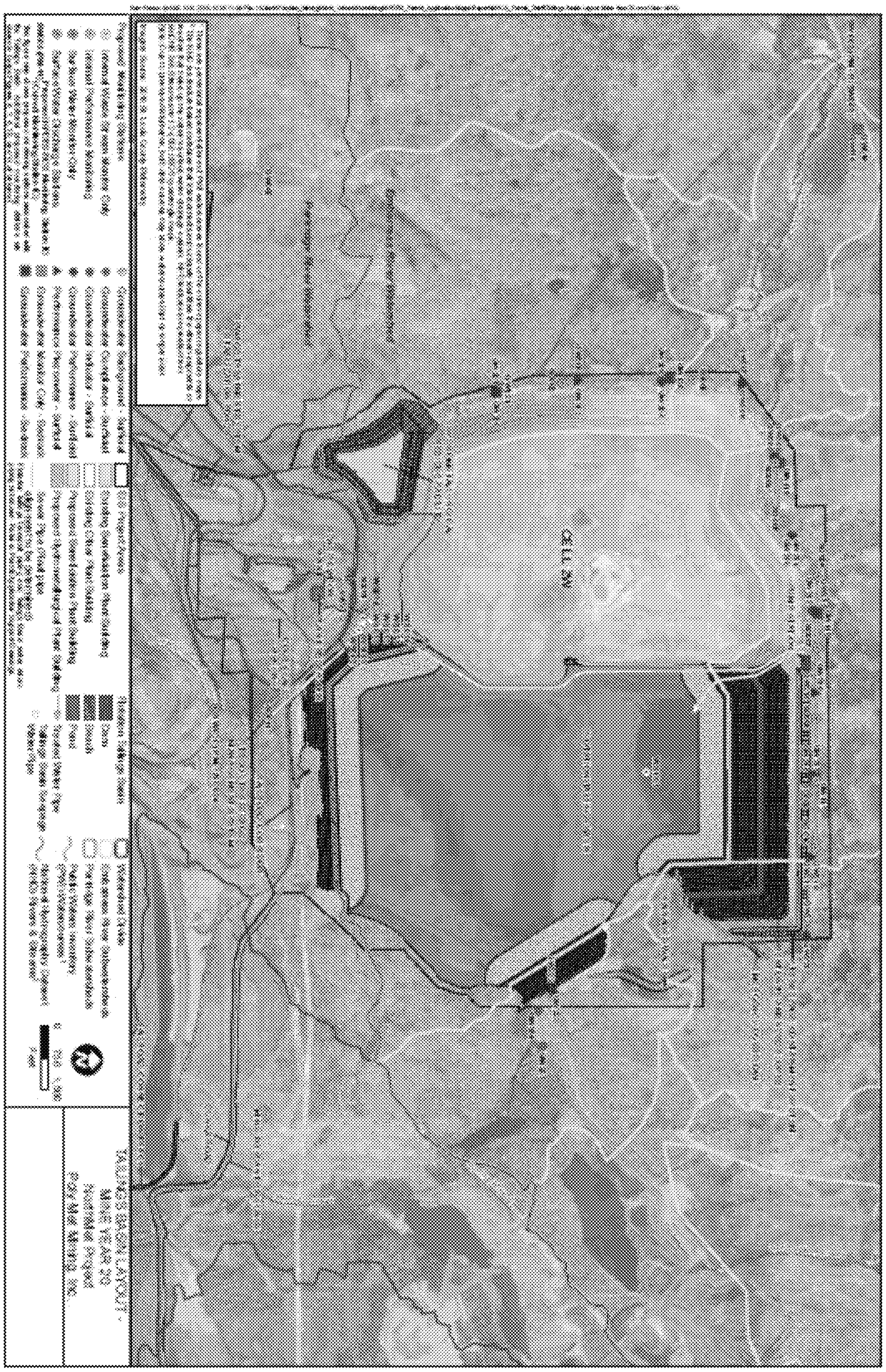
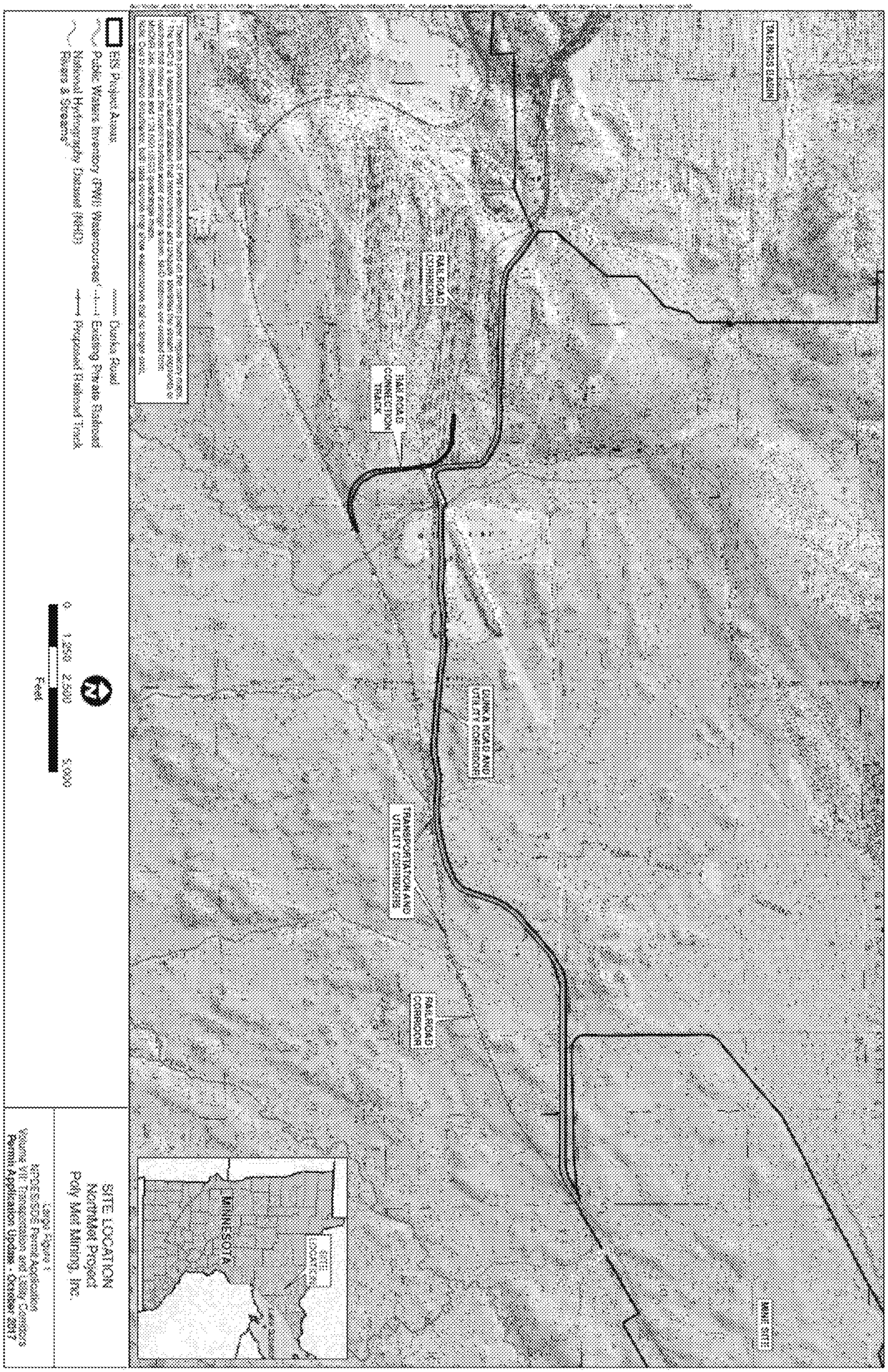


Figure 7 – Transportation and Utility Corridor Map



Facility Description

Mine Site

The Mine Site is a relatively undisturbed site that will be developed into an open pit mine. Development of the Mine Site for the Project will include construction of new facilities, including mine pits, ore handling facilities, waste rock stockpiles, an overburden storage area, mine water management systems, an Equalization Basin Area, and supporting infrastructure.

The Mine Site will include the following Project features:

- three mine pits (the East Pit, West Pit, and Central Pit)
- ore handling facilities, including an Ore Surge Pile (OSP) and a Rail Transfer Hopper (RTH)
- Category 1, 2/3, and 4 Waste Rock Stockpiles and the OSP with engineered systems such as liners, covers, and a groundwater containment system, to manage precipitation that will run off of or percolate through the stored waste rock
- an Overburden Storage and Laydown Area (OSLA) to provide space to sort and store unsaturated mineral overburden and peat used for construction and reclamation
- mine water collection systems and an Equalization Basin Area to collect mine water from the mine pits, the stockpiles, the ore handling facilities, OSLA, construction areas, and the driving surface of haul roads
- a Central Pumping Station (CPS), Construction Mine Water Pumping Station, and Mine to Plant Pipelines (MPP) to transport *mine water* from the Mine Site to the Plant Site
- stormwater management systems

The location of the Mine Site and Mine Site features is shown on Figures 3 and 4.

Mine Pits and Mine Pit Dewatering

Mine Pits

The Project will involve mining from three open pits, the East Pit, the West Pit and the Central Pit. Mining will begin in the East Pit in Mine Year 1 followed by commencement of mining in the West Pit. Mining from the West Pit is anticipated throughout the life of the mine. Mining from the East Pit will cease before the end of the life of the mine, and thereafter backfilling of the pit with waste rock from the temporary Category 2/3 and Category 4 waste rock stockpiles will begin. Mining from the Central Pit will begin once the Category 4 waste rock stockpile is backfilled into the East Pit. Once backfilling begins, waste rock from the West and Central Pits will be used to backfill the East Pit, as well as the Central Pit, once mining ceases in each pit.

The maximum surface footprint of the East Pit, the West Pit and Central Pits will be approximately 155 acres, 321 acres and 52 acres respectively, and maximum depths will be approximately 700 feet, 630 feet and 350 feet respectively.

Mine Pit Dewatering

Each of the mine pits will require mine pit dewatering to remove groundwater and runoff from areas within the pits. This water will be directed to sumps within the pits where it will be collected and pumped to the equalization basins for further conveyance to the Waste Water Treatment System (WWTS) at the Plant Site.

Waste Rock Stockpiles

Temporary Category 2/3 Waste Rock and Category 4 Waste Rock Stockpiles and Ore Surge Pile

The Category 2/3 Waste Rock Stockpile and the Category 4 Waste Rock Stockpile will temporarily store higher sulfur waste rock that may generate acidic leachate until the waste rock can be backfilled into the East and Central Mine Pits. The Ore Surge Pile will be used to temporarily store ore, with ore moving in and out as needed to meet mine and plant conditions. Each of these temporary features will include an engineered liner system consisting of a compacted foundation, an underdrain system (if needed), an geomembrane liner over a compacted soil liner and an overliner drainage layer. Drainage from each stockpile will be collected in a sump and pond system and will be conveyed to the equalization basins for further conveyance to the WWTS at the Plant Site for further treatment. The maximum surface footprint of the Category 2/3 Waste Rock Stockpile and the Category 4 Waste Rock Stockpile is expected to be approximately 180 acres and 57 acres respectively, with maximum heights above ground surface of approximately 200 feet and 180 feet respectively.

Permanent Category 1 Waste Rock Stockpile

The Category 1 Waste Rock Stockpile will be the only permanent waste rock stockpile on site. Category 1 waste rock is of lower sulfur content and is not expected to generate acidic leachate but may leach heavy metals. Drainage from the Category 1 Waste Rock Stockpile will be collected by a groundwater containment system that consists of a low permeability barrier with a collection system on the inward side that will be operated to maintain an inward hydraulic gradient. The drainage collected by the groundwater containment system will be conveyed to the equalization basins for further conveyance to the WWTS at the Plant Site for treatment. The maximum surface footprint of the Category 1 Waste Rock stockpile at full development is expected to be approximately 526 acres with a maximum height of approximately 280 feet above the ground surface.

Overburden Storage and Laydown Area (OSLA)

The OSLA is a temporary storage area for unsaturated overburden and peat that will be used in construction and reclamation. The OSLA will be graded and compacted to direct runoff to a collection pond from where it will be pumped to the Construction Mine Water Basin for further conveyance to the FTB at the Plant Site via the Mine to Plant Pipelines (MPP) or, during East and Central Pit filling, for conveyance to these pits.

Mine Water Collection Systems

Mine water will include water that has contacted surfaces disturbed by mining activities including the aforementioned mine pit dewatering and stockpile drainage as well as runoff contacting ore, waste rock and Mine Site haul road surfaces. Mine water will be intercepted throughout the Mine Site by ditches, dikes, stockpile liners, and the stockpile groundwater containment system and routed to the Equalization Basin Area where it will be kept segregated in ponds by waste strength as described in the Plant Site section below. There will be no direct discharge of mine water or other process wastewater to surface waters from the Mine Site.

Internal monitoring points, groundwater monitoring wells and piezometers, and surface water monitoring will be located at or near the Mine Site and are described in the Monitoring Summary section of the permit.

Plant Site

The Plant Site is located approximately 6-7 miles west of the Mine Site. It is a developed site which includes a former taconite processing facility and tailings basin previously operated by LTVSMC. Redevelopment of the Plant Site for the Project will include refurbishment of former LTVSMC processing facilities and construction of new facilities. Plant Site features will include:

- a Beneficiation Plant
- a Hydrometallurgical Plant
- a Flotation Tailings Basin (FTB) including Seepage Capture Systems
- a Hydrometallurgical Residue Facility (HRF)
- a Waste Water Treatment System (WWTS)
- a Sewage Treatment System
- other ancillary facilities (e.g., Colby Lake water pipeline).

The location of the Plant Site and Plant Site features is shown on Figures 5 and 6.

Beneficiation Plant and Flotation Tailings Basin

Beneficiation Plant

The Beneficiation Plant will process ore to produce nickel and copper concentrates. Ore will be crushed at the Coarse Crusher Building, ground in the semi-autogenous grinding mill and ball mill at the Concentrator Building, and then sent to the Flotation Building. In flotation, the minerals containing base and precious metals will be separated from the tailings using a combination of flotation reagents.

The Beneficiation Plant will process approximately 32,000 tons of ore per day, and produce approximately 660 tons per day of copper and nickel concentrates and approximately 31,340 tons per day of Flotation Tailings. Copper concentrates will be dewatered and shipped to customers via rail. Nickel concentrates will be dewatered and shipped directly to customers via rail until the Hydrometallurgical Plant is built to process them on-site. Flotation Tailings will be pumped as a slurry to the FTB.

The Beneficiation Plant will produce Flotation Tailings throughout the planned 20 years of ore processing. Flotation Tailings will be pumped as a slurry to the FTB, which will be constructed atop Cells 1E and 2E of the former LTVSMC tailings basin. Water from the FTB will be recycled back to the Beneficiation Plant and will not be directly discharged to surface waters during operations. The only direct discharge to surface waters from the facility will be treated effluent from the WWTS discharged through outfall SD001.

The Beneficiation Plant will require an annual average of approximately 13,800 gpm of water for processing. Nearly all this water (99%) will be piped with the tailings to the FTB; less than 1% will be lost to evaporation in the plant or included with the concentrate. Water for Beneficiation Plant processes will come primarily from the FTB Pond. Other minor sources of water will include water in the raw ore, reagents, and gland seals of slurry pumps. Make-up water, as needed, will be drawn from the Plant Reservoir which will be supplied with raw water pumped from Colby Lake under terms of a water appropriation permit from the Minnesota Department of Natural Resources (MDNR). Average annual make-up water demand from Colby Lake is expected to vary from about 260 gpm to up to 1,760 gpm (with an average of about 760 gpm) depending on precipitation and Mine Year. Water will be conveyed from Colby Lake via an existing pipeline, located within the Colby Lake Corridor, previously used by LTVSMC in its taconite operations. PolyMet will refurbish and maintain the existing pipeline and pumphouse as necessary for its use.

Flotation Tailings Basin

The FTB is designed to contain flotation tailings generated over the planned 20 years of operation. The FTB will be constructed atop the existing LTVSMC tailings basin. The FTB will be constructed in stages, gradually increasing in elevation and size. Initially, flotation tailings will be placed in existing Cell 2E. Eventually (currently estimated to be approximately Mine Year 7), Cell 2E will merge with Cell 1E and flotation tailings will be placed in combined Cell1E/2E. The FTB perimeter dams will be raised in an upstream construction method utilizing LTVSMC coarse tailings. A bentonite amended layer will be placed on exterior sides of the FTB dams to limit oxidation of the tailings. The FTB dams will be constructed and operated in accordance with Minnesota dam safety regulations administered by the MDNR.

The FTB Pond will receive water from the following sources during operations: process water/tailings slurry from the Beneficiation Plant, captured seepage from the FTB seepage capture systems, treated mine water, filter backwash and clean-in-place wastes from the WWTS, construction mine water/OSLA runoff from the Mine Site, treated effluent from the Sewage Treatment System, and precipitation and runoff from within the FTB dams and tributary to the FTB Pond.

The FTB is designed and will be operated to prevent overflow of the system – there will be no direct discharge from the FTB Pond to any surface waters. Pond water levels will be managed to maintain adequate freeboard by adjusting the relative amount of collected tailings basin seepage routed to the FTB Pond and to the WWTS. Freeboard requirements and other terms relating to the operation of the FTB are established by the MDNR dam safety permit.

FTB Seepage Capture Systems

Historically, water has seeped from the LTVSMC tailings basin by infiltrating through the tailings basin and migrating through the base of the external dam faces. This seepage contributed to exceedances of permit effluent limitations established in the NPDES/SDS permit currently held by Cliffs Erie for the former LTVSMC tailings basin. Cliffs Erie and MPCA entered into a Consent Decree in 2010 to resolve the permit limit exceedances associated with the tailings basin. Cliffs Erie has taken various measures to address these exceedances and is in compliance with the Consent Decree; however, the Consent Decree does not require elimination of the seepage and seepage from the tailings basin is continuing.

As part of the Project, PolyMet will construct seepage capture systems to collect seepage from the FTB. The FTB Seepage Containment System and the FTB South Seepage Management System (collectively known as the FTB seepage capture systems) will collect water seeping from the combined former LTVSMC basin and the FTB (collectively, the Tailings Basin) via surface or shallow groundwater flow. The FTB seepage capture systems are expected to provide a permanent remedy to the water quality exceedances associated with the seepage from the existing tailings basin.

The FTB Seepage Containment System will surround the western and northern sides and extend to a portion of the eastern side of the Tailings Basin. It will consist of a cutoff wall installed to the top of the bedrock, with a collection trench and drain pipe installed on the upgradient side (Tailings Basin side) of the cutoff wall. The FTB Seepage Containment System will collect water seeping from the Tailings Basin via surface and shallow groundwater flow, as well as runoff from the exteriors of the dams on the northern, northwestern, western, and eastern sides of the Tailings Basin, and from the small watershed area between the toes of the dams and the FTB Seepage Containment System.

The FTB South Seepage Management System, which currently operates as the temporary Cliffs Erie SD026 pumpback system installed under the 2010 Consent Decree, consists of a berm, trench, and pumpback system and collects seepage on the southern side of the FTB. During Project operations, PolyMet will upgrade the existing system to enhance the degree of seepage collection as necessary.

Seepage from both the FTB Seepage Containment System and the FTB South Seepage Management System will be routed to the WWTS for treatment prior to discharge to the receiving waters. This discharge of treated water will augment water levels in the receiving waters, which will receive less in-flow due to the installation of the FTB seepage capture systems. As discussed further below, this augmentation is intended to maintain the hydrologic and ecologic integrity of the receiving waters. This augmentation will be subject not only to this NPDES/SDS permit for the Project, but also a MDNR water appropriation permit. Some seepage will also be recycled directly to the FTB Pond for reuse in the processing facilities. The amount of seepage to be treated at the WWTS and discharged will depend on operational factors, precipitation, allowable discharge requirements of 40 CFR part 440, and requirements of the MDNR water appropriation permit.

Hydrometallurgical Plant/Hydrometallurgical Residue Facility

Hydrometallurgical Plant

The Hydrometallurgical Plant will process nickel concentrates from the Beneficiation Plant, extracting a copper concentrate, a mixed nickel-cobalt (Ni/Co) hydroxide, and a gold and platinum-group elements (Au/PGE) precipitate. The Hydrometallurgical Plant may not be built for several years after mining starts. Before the Hydrometallurgical Plant is built, the company will ship the nickel concentrates from the Beneficiation Plant directly to customers. The timing for construction of the Hydrometallurgical Plant will depend on customer requirements and overall Project economics.

The hydrometallurgical process will involve high pressure and temperature autoclave leaching followed by several solution purification steps. Inputs will include the nickel concentrates from the Beneficiation Plant, water from the HRF Pond and the Plant Reservoir, various process consumables, and chemical additives. Waste residues from the hydrometallurgical process will be pumped as a slurry for final disposal to the HRF.

The Hydrometallurgical Plant and HRF will operate as a closed-loop system with no discharge to groundwater or surface waters or to the FTB/WWTS system. Water for Hydrometallurgical Plant processes will include recycled HRF water from the HRF Pond (approximately 172 gpm) and make-up water from Colby Lake via the Plant Reservoir (at approximately 230 gpm).

If all nickel concentrate streams from the Beneficiation Plant are processed at the Hydrometallurgical Plant, annual production currently is expected to total about 113,000 tons of copper concentrate, 18,000 tons of mixed nickel-cobalt (Ni/Co) hydroxide, and 500 tons of gold and platinum-group elements (Au/PGE) precipitate. This will result in generation of approximately 313,000 tons of residue per year for disposal in the HRF. These totals will decrease if some flotation concentrates are shipped directly to customers.

Hydrometallurgical Residue Facility (HRF)

The HRF will be designed to permanently store residue from the hydrometallurgical process generated over the life of the Project and may also receive wastewater treatment solids from the WWTS. The HRF will be constructed at the former LTVSMC Emergency Basin (Emergency Basin) near the southwestern corner of the existing tailings basin.

The HRF will function as a large-scale sedimentation basin. Residue will be pumped as slurry to the HRF, where it will settle out. Residue slurry from the Hydrometallurgical Plant will be pumped to the HRF through a pipe with multiple discharge points into the HRF. A pond will be maintained within the cell such that the solid fraction of the slurry (the Residue) settles out, while the majority of the liquid fraction is recovered by the return water system and pumped back to the Hydrometallurgical Plant for reuse. The water level and dam height in the HRF will be managed as needed to facilitate Residue deposition at the desired locations within the HRF and to achieve the desired water clarity for process water at the Hydrometallurgical Plant in accordance with Minnesota dam safety regulations administered by the MDNR.

The HRF is designed as a closed system: no water from the HRF will be released to the environment through overflow or outlet structures. The HRF is designed with a double liner with a Leakage Collection System between the two liners to prevent leakage to groundwater. Any leakage collected in the leakage collection system will be routed back to the HRF pond. The HRF Leakage Collection System is further described in Volume 6 of the October 2017 Permit Application.

Plant Site Sewage Treatment System

Sewage generated from various buildings at the Plant Site, sewage generated at the Mine Site, and filter backwash from the Plant Site Potable Water Treatment Plant will be collected and routed to a Plant Site Sewage Treatment System (STS). The STS will consist of a stabilization pond system. The STS will be designed for an initial average daily flow of approximately 8,500 gallons per day (gpd) and average wet weather flow of approximately 21,500 gpd with expansion up to an average daily flow of approximately 13,750gallons per day (gpd) and average wet weather flow of approximately 26,750 gpd.

Existing piping will be used to collect sewage from existing facilities at the Plant Site and will be refurbished to minimize infiltration and inflow to the collection system. New piping and associated infrastructure will also be added to connect new Plant Site facilities to the collection system and the stabilization ponds. Sewage at the Mine Site will be collected in portable facilities and trucked to the Plant Site STS.

The proposed stabilization ponds will consist of two lined primary ponds and one lined secondary pond with operating depths of approximately four feet. The secondary pond will discharge to the FTB Pond via a pump station. The controlled discharge will occur in the spring and fall of each year. Each controlled discharge will typically last 10 to 14 days, depending on weather conditions.

Wastewater Treatment System (WWTS)

The WWTS will be located at the Plant Site and will house the process equipment for two separate treatment trains known as the mine water treatment trains and the tailings basin seepage treatment train. The primary components of the WWTS for the Project will include the Equalization Basin Area located at the Mine Site, the Mine to Plant Pipelines (MPP), and the WWTS building and associated Pretreatment Basin.

The WWTS will treat mine water and tailings basin seepage. Mine water flows will be segregated based on projected water quality or waste strength and treated in two mine water treatment trains. The mine water chemical precipitation train will treat high-concentration mine water and also treat WWTS membrane treatment concentrate. The mine water filtration train will treat low-concentration mine water using membrane separation. Separately, the WWTS will also treat tailings basin seepage using a combination of membrane separation treatment technologies (such as reverse osmosis and/or nanofiltration).

Equalization Basin Area
In the Equalization Basin Area located at the Mine Site, mine water will be managed based on the projected water quality. Construction mine water and OSLA runoff will be routed to the Construction Mine Water Basin. Mine water from low-volume sources (e.g., temporary waste rock stockpiles) that are expected to have relatively high concentrations of dissolved constituents will be routed to the High Concentration Equalization (HCEQ) Basin. Mine water from high-volume sources, (e.g., mine pits, haul roads and RTH area) that are expected to have relatively low concentrations of dissolved constituents will be routed to the Low Concentration Equalization (LCEQ) Basin 1 and LCEQ Basin 2. The distinction between these two groups of mine water sources is the basis for the use of two separate treatment trains: chemical precipitation for the low-volume, high-concentration flows and membrane separation for the high-volume, low-concentration flows. The assignment of wastewater from individual sources to a particular basin (i.e., LCEQ vs. HCEQ basin) will be based on the actual chemistry of the wastewater. For example, if wastewater from mine pit dewatering has concentrations that are more amenable to treatment by chemical precipitation, it will be routed to the HCEQ basin rather than to one of the LCEQ basins. Furthermore, as mining operations progress and wastewater concentrations change, it is possible that the assignments could change as well; what once went to the LCEQ could later be routed to the HCEQ, and vice versa. The intent is to match the wastewater chemistry from a source with the most effective treatment of that wastewater (i.e., chemical precipitation vs. membrane filtration).

Mine to Plant Pipelines
Three pipelines (collectively referred to as the MPP) will convey water between the Mine Site and the Plant Site. The Construction Mine Water Pipeline will transport construction mine water and runoff from the OSLA Pond to the FTB. Once pit backfilling begins, runoff from the OSLA pond will be routed to the East and Central Pits, and concurrently water from the WWTS will be conveyed through the Construction Mine Water Pipeline to the East and Central Pits to aid in pit flooding. The Low Concentration Mine Water Pipeline will transport mine water from the LCEQ Basins to the mine water filtration treatment train at the WWTS; and the High Concentration Mine Water Pipeline will transport mine water from the HCEQ Basin to the mine water chemical precipitation treatment train at the WWTS.

The MPP alignment is generally parallel to Dunka Road. The alignment of the three pipelines will diverge within the Plant Site where the Construction Mine Water Pipeline will head north to the FTB and the Low Concentration Mine Water Pipeline and High Concentration Mine Water Pipeline will go the WWTS. The locations of the MPP are shown on Figure 7.

Mine Water Chemical Precipitation Train
The mine water chemical precipitation train is designed to treat the low-volume flows from the sources with high concentrations of dissolved constituents. These sources are currently expected to be primarily drainage from the Category 2/3 and Category 4 Waste Rock Stockpiles and the Ore Surge Pile (however, depending on the actual water quality of this drainage, some or all of it could be routed to the mine water filtration train described below). Secondary membrane concentrate (membrane reject water) from the tailings basin seepage treatment train and the mine water treatment trains will also be routed to the chemical precipitation train along with greensand filter backwash solids. Treated water from the mine water chemical precipitation train will be routed directly to the FTB. The mine water chemical precipitation treatment train will consist of headworks, chemical precipitation, and associated solids handling works and is further described in Volume 3 of the October 2017 permit application.

Mine Water Filtration Train

The mine water filtration train is designed to treat mine water with relatively low concentrations of sulfate and metals and high flow rates, compared to the influent to the chemical precipitation train. Mine water sources currently expected to be routed to the mine water filtration train include mine pit dewatering and runoff from mine haul roads and the RTH area. Treated water from the mine water filtration will be routed directly to the FTB. The mine water filtration treatment train will consist of headworks, greensand filtration, primary membrane separation, and secondary membrane separation and is further described in Volume 3 of the October 2017 permit application.

Tailings Basin Seepage Treatment Train

The influent to the tailings basin seepage treatment train will consist primarily of tailings basin seepage collected by the FTB seepage capture systems. The tailings basin seepage treatment train will consist of a pre-treatment basin, greensand filtration, primary membrane separation (such as RO), secondary membrane separation, and permeate stabilization prior to discharge. The tailings basin seepage treatment train is further described in Volume 3 of the October 2017 permit application.

Wastewater Treatment Solids/Byproducts

The mine water treatment trains will produce byproduct streams as a result of filter and membrane cleaning. These streams will be the clean-in-place membrane waste and the greensand filter backwash and will be routed to the FTB. Excess sludge from high-density sludge precipitation, gypsum precipitation, and calcite precipitation will be dewatered in a filter press. Dewatered sludge will be disposed of at the HRF or disposed at a permitted solid waste facility. Filtrate will be routed to the chemical precipitation train for treatment.

The byproducts from the tailings basin seepage treatment train will include waste from filter and membrane cleaning and concentrate from the secondary membrane separation process. Waste from the filter and membrane cleaning will be routed to the FTB pond. Secondary membrane concentrate will be routed to the mine water chemical precipitation treatment train for treatment.

Wastewater Treatment System Discharge

The WWTS discharge from the tailings basin seepage treatment train (WWTS discharge) will be piped to maintain flows in Trimble Creek, Second Creek, and Unnamed Creek. Some seepage will be recycled directly to the FTB Pond for reuse. Effluent from mine water treatment trains (treated mine water) will be routed to the FTB Pond.

Treated tailings basin seepage will be routed to the Treated Water Storage Tank (SD001), where effluent water quality will be monitored. From there the effluent will be pumped to the individual surface water discharge outfalls located in the headwaters of each of the receiving surface waters. Outfalls SD002 and SD003 discharge to headwater wetlands of Unnamed Creek, Outfalls SD004 through SD010 are located in headwater wetlands of Trimble Creek, and Outfall SD011 is located in the headwater segment of Second Creek. The WWTS discharge will be distributed to these tributaries in proportion to the flow required to minimize hydrologic or ecologic impacts resulting from the reduction in available source water to the streams from installation of the FTB seepage capture systems. The flow rate to each outfall will be monitored in the distribution box where the treated effluent from SD001 is divided to the individual outfalls. The discharge locations are shown in Figure 8.

The wetland headwaters to Unnamed and Trimble Creeks are Class 2D, 3D, 4C, 5, and 6 waters under Minn. R. 7050.0425 and the headwater segment of Second Creek is a Class 2B, 3C, 4A, 4B, 5, and 6 water under Minn. R. 7050.0430. Approximate discharge rates from the WWTS to each of the individual outfalls are shown in Table 1 below.

Table 1 - Proposed Discharge Rates

Station ID	Discharge Flow Rate Average (MGD)		Discharge Flow Rate Maximum (MGD)		Discharge Frequency	Receiving Waters
	Mine Year 1(1)	Mine Year 10(2)	Mine Year 1(1)	Mine Year 10(2)		
SD002	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Unnamed Creek
SD003	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Unnamed Creek
SD004	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Trimble Creek
SD005	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Trimble Creek
SD006	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Trimble Creek
SD007	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Trimble Creek
SD008	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Trimble Creek
SD009	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Trimble Creek
SD010	0.24	0.39	0.29	0.57	Continuous	Wetlands in the headwater area of Trimble Creek
SD011	0.27	0.40	0.31	0.59	Continuous	Headwater segment of Second Creek

(1) Mine Year 1 will be the first year of discharge from the WWTS, and for the first 15 years of the Project, is expected to be the year of minimal discharge and loading from the WWTS.

(2) Mine Year 10 is expected to be the year of maximum discharge and maximum loading from the WWTS.

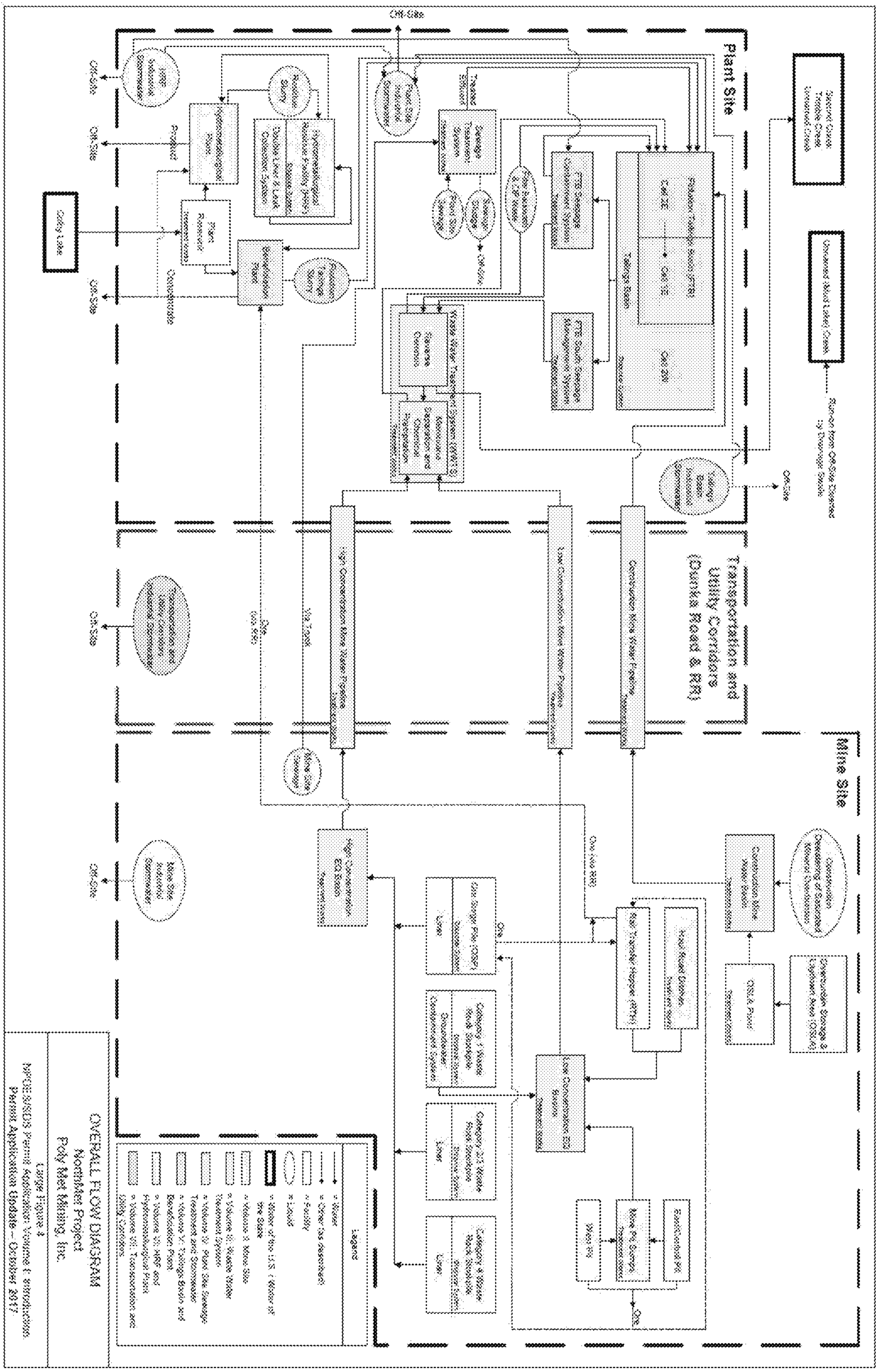
Transportation and Utility Corridors

The Transportation and Utility Corridors provide connections between the Mine Site and the Plant Site for ore transport, vehicle traffic, mine water conveyance, and power transmission. These corridors include the existing Dunka Road and utility corridor and existing railroad corridor. A new segment of rail corridor also will be utilized to construct the Railroad Connection Track for the Project. Runoff from the Transportation and Utility Corridors will be managed under the National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Construction Stormwater General Permit (MNR100001) (the Construction Stormwater General Permit) and the NPDES/SDS Industrial Stormwater General Permit (MNR050000) (the ISW General Permit) and is not covered under this NPDES/SDS permit.

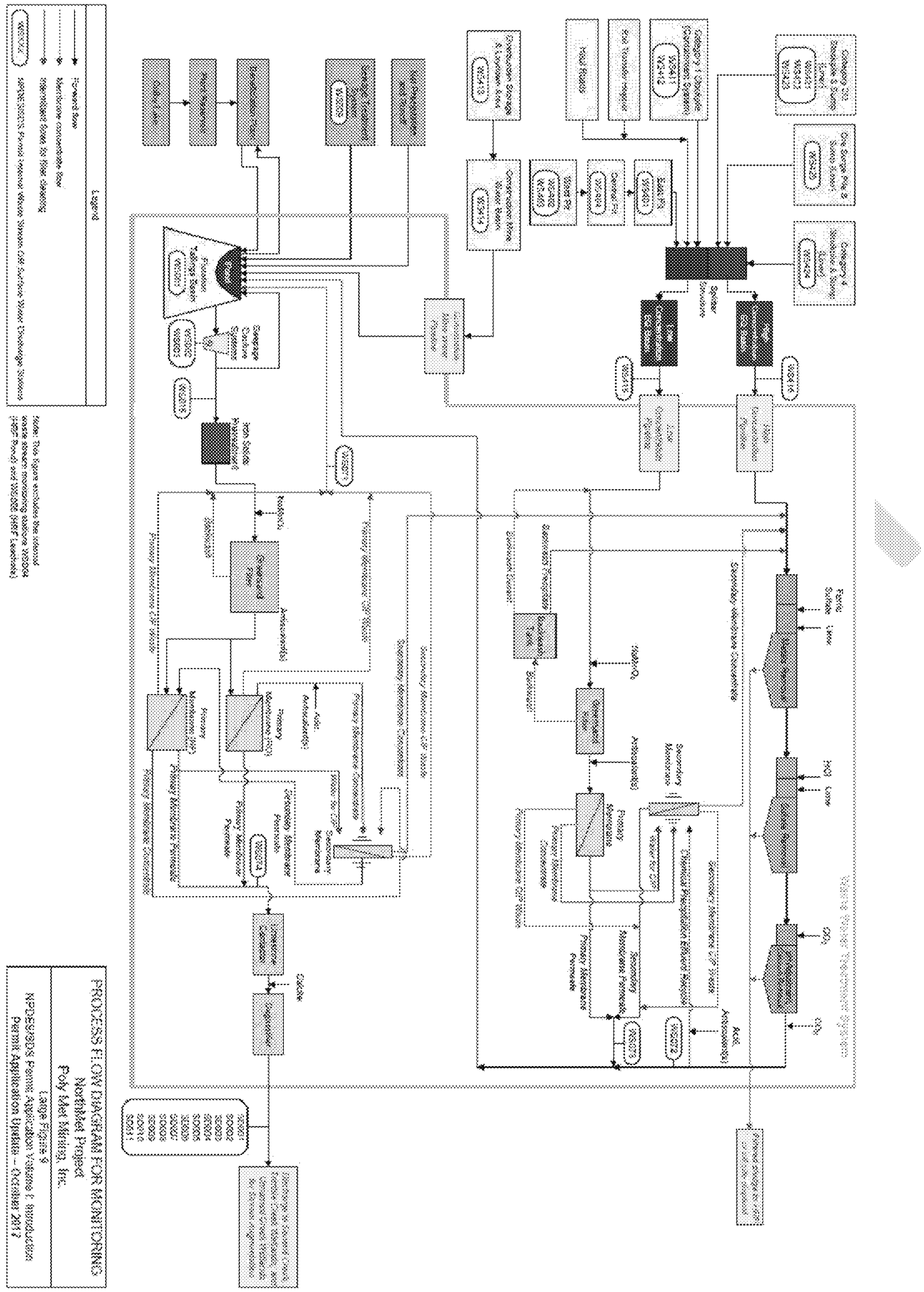
Summary Statement

MPCA has determined that the Project as designed does not have reasonable potential to cause or contribute to any violations of any applicable water quality standards in waters of the state. These standards include numeric and narrative water quality criteria, antidegradation standards for surface water, nondegradation standards for groundwater, and beneficial use designations. The permit includes extensive requirements to ensure that the Project will comply with all applicable water quality standards. The permit also includes requirements to ensure the Project will be constructed and operated consistent with the design reviewed in the final environmental impact statement (FEIS).

Flow Schematic



Process Flow Diagram



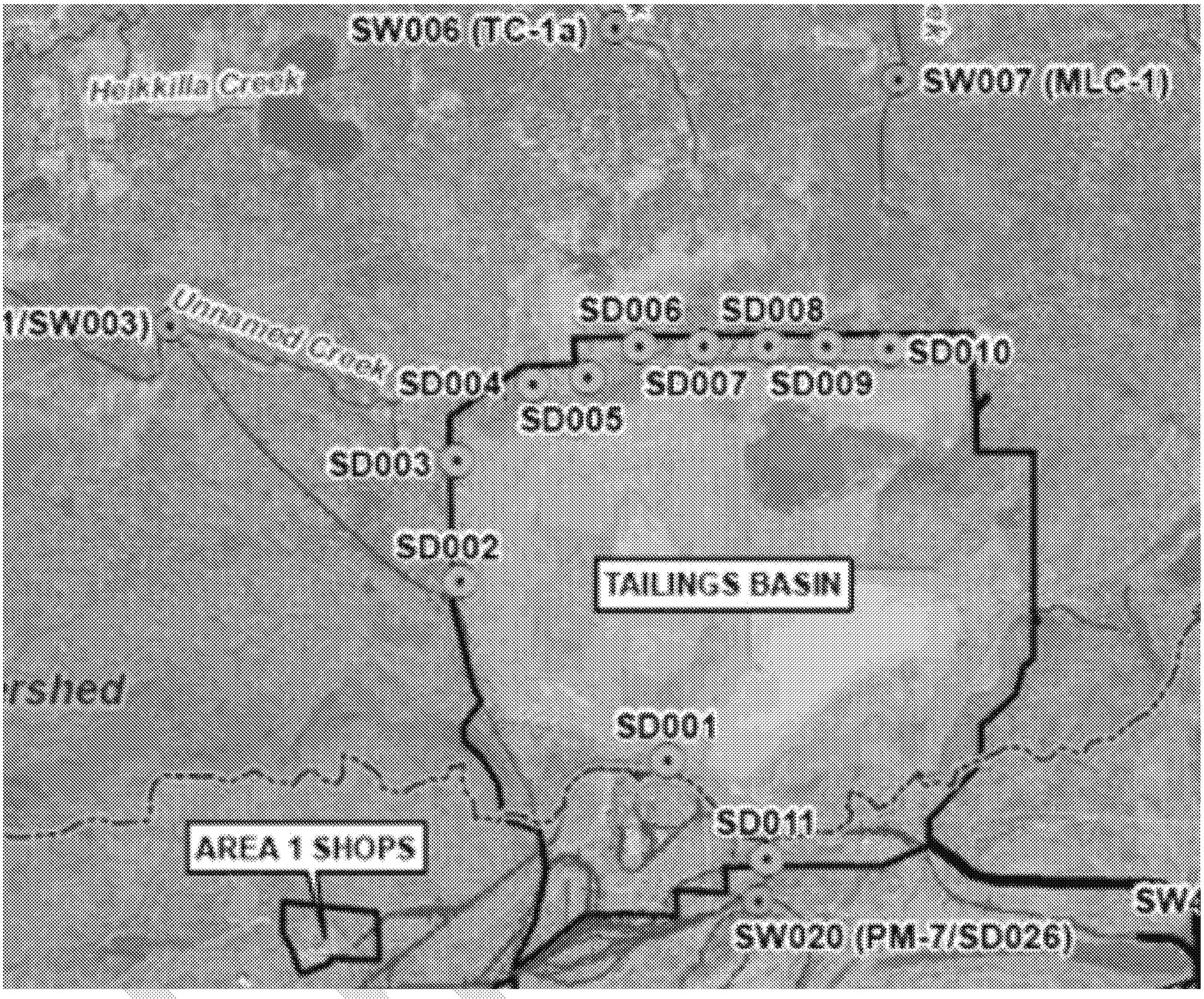
Proposed Outfall Locations

Outfall SD001 will monitor effluent water quality for compliance at the point of discharge from the WWTS. The effluent is then distributed to three separate streams (Unnamed Creek, Trimble Creek, and Second Creek), via Outfalls SD002 – SD011. Treated effluent is distributed to wetlands in the headwaters area of Unnamed Creek on the west side of the FTB via Outfalls SD002 and SD003. Treated effluent is distributed to wetlands in the headwaters area of Trimble Creek to the north of the FTB via Outfalls SD004 – SD010. Treated effluent is distributed directly to the headwaters segment of Second Creek via Outfall SD011. Table 2 and Figure 8 provide further details about the discharge locations.

Table 2 - Facility Discharge and Outfall Location

Station ID	Township	Range	Section	¼ Section	¼ of ¼ Section	Receiving Water
SD001	59 N	14 W	9	SW	NW	• Wetlands in the headwater area of Unnamed Creek • Wetlands in the headwater area of Trimble Creek • Second Creek
SD002	59 N	14 W	5	SW	SW	Wetlands in the headwater area of Unnamed Creek
SD003	59 N	14 W	5	NW	NW	Wetlands in the headwater area of Unnamed Creek
SD004	60 N	14 W	32	SE	SW	Wetlands in the headwater area of Trimble Creek
SD005	60 N	14 W	32	SE	SE	Wetlands in the headwater area of Trimble Creek
SD006	60 N	14 W	33	SW	NW	Wetlands in the headwater area of Trimble Creek
SD007	60 N	14 W	33	SW	NE	Wetlands in the headwater area of Trimble Creek
SD008	60 N	14 W	33	SE	NW	Wetlands in the headwater area of Trimble Creek
SD009	60 N	14 W	34	SW	NW	Wetlands in the headwater area of Trimble Creek
SD010	60 N	14 W	34	SW	NE	Wetlands in the headwater area of Trimble Creek
SD011	59 N	14 W	16	NE	NW	Second Creek

Figure 8 - Locations of Proposed Outfalls



Receiving Waters and Downstream Waters

Use Classification

The discharges from the WWTS will be conveyed to three receiving waters: wetlands tributary to Unnamed Creek; wetlands tributary to Trimble Creek; and the headwater segment of Second Creek. These are the only receiving waters authorized by the permit. The wetlands are classified as Class 2D, 3D, 4C, 5, and 6 waters under Minn. R. 7050.0425. Unnamed Creek (SD002-SD003), Trimble Creek (SD004-SD010), and Second Creek (SD011) are all Class 2B, 3C, 4A, 4B, 5, and 6 waters under Minn. R. 7050.0430. The designated uses under these classifications include aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other beneficial uses not specifically listed. These use designations are further described below:

7050.0222 Subp. 4: Class 2B waters.

The quality of Class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface water is not protected as a source of drinking water.

7050.0222 Subp. 6: Class 2D waters; wetlands.

The quality of Class 2D wetlands shall be such as to permit the propagation and maintenance of a healthy community of aquatic and terrestrial species indigenous to wetlands, and their habitats. Wetlands also add to the biological diversity of the landscape. These waters shall be suitable for boating and other forms of aquatic recreation for which the wetland may be usable.

7050.0223 Subp. 4: Class 3C waters.

The quality of Class 3C waters of the state shall be such as to permit their use for industrial cooling and materials transport without a high degree of treatment being necessary to avoid severe fouling, corrosion, scaling, or other unsatisfactory conditions.

7050.0224 Subp. 2: Class 4A waters.

The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area, including truck garden crops.

7050.0224 Subp 3: Class 4B waters.

The quality of Class 4B waters of the state shall be such as to permit their use by livestock and wildlife without inhibition or injurious effects.

7050.0225 Subp. 2: Class 5 waters.

The quality of Class 5 waters of the state shall be such as to be suitable for aesthetic enjoyment of scenery, to avoid any interference with navigation or damaging effects on property.

7050.0226 Subp. 2: Class 6 waters.

The uses to be protected in Class 6 waters may be under other jurisdictions and in other areas to which the waters of the state are tributary, and may include any or all of the uses listed in parts 7050.0221 to 7050.0225, plus any other possible beneficial uses.

Downstream Water Conditions

Impairments

MPCA monitors surface water and lists waters that do not meet state water quality standards as "impaired." None of the receiving waters are listed as impaired, but as discussed below, certain downstream waters have been listed. The Project is not expected to contribute to any downstream impairments.

Embarrass River:

Outfalls SD002 and SD003 discharge to the headwater wetlands of Unnamed Creek and Outfalls SD004 – SD010 discharge to the headwater wetlands of Trimble Creek. Both Unnamed Creek and Trimble Creek flow to the Embarrass River. The Embarrass River is listed on MPCA's Impaired Waters List for "fishes bioassessments." The St. Louis River Watershed Monitoring and Assessment Report is complete; however, a TMDL has not been developed to address this impairment. Additional impairments in the Embarrass River watershed include "mercury in fish tissue" and "mercury in the water column." Mercury impairments will be addressed through future TMDL(s).

Partridge River:

Outfall SD011 discharges to the headwater segment of Second Creek, which flows to the Partridge River. The Partridge River is listed on MPCA's Impaired Waters List for "mercury in fish tissue" and "mercury in the water column." Mercury impairments will be addressed through future TMDL(s).

St. Louis River:

The Embarrass and Partridge Rivers ultimately flow into the St. Louis River. The St. Louis River is listed on MPCA's Impaired Waters List "aquatic macroinvertebrate bioassessment" and "fecal coliform" (at St. Louis Bay). These impairments are located in the St. Louis River Watershed. The St. Louis River Watershed Monitoring and Assessment Report is complete; however, a TMDL has not been developed to address these impairments. The St. Louis River also is listed on MPCA's Impaired Waters List for "mercury in fish tissue" and "mercury in the water column." The permit contains monitoring for mercury in accordance with the MPCA's Mercury Policy (for permits) and Minn. R. 7052.0250, subp. 4.

Additional Information

Efforts are ongoing to address the Beneficial Use Impairments for the downstream St. Louis River Area of Concern and are further described in the Implementation Framework: Roadmap to Delisting (July 15, 2013) and the St. Louis River Area of Concern 2013 Progress Report. There are a number of PCB, DDT, Dieldrin, Dioxin and Toxaphene impairments that were not specifically outlined in the impaired waters review. TMDLs are not underway for these impairments at this time. The St. Louis River Area of Concern is located at the mouth of the St. Louis River in Duluth, approximately 175 river miles downstream. The Project will not discharge any of these constituents.

Wasteload Allocations

There are no draft or final wasteload allocations assigned to this facility's proposed discharges at this time.

Wild Rice

MPCA regulations currently contain a Class 4A water quality standard of 10 mg/L for sulfate concentrations "applicable to water used for the production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels." As discussed in the FEIS (pp. 4-32 - 4-33), in 2012 MPCA developed a draft staff recommendation that the 10 mg/L sulfate standard be determined to be applicable to certain portions of the Partridge River and Embarrass River used for the production of wild rice. Some of these identified segments of the Partridge River and Embarrass River containing wild rice are downstream of the Project, but those segments are not receiving waters into which discharges from the WWTS will occur. Nonetheless, pending potential changes in the wild rice water quality standard, PolyMet has incorporated into the Project a design of the WWTS that will meet a 10 mg/L concentration for sulfate at the point of discharge into the Project's receiving waters.

Reasonable Potential

Background/Site Description
The discharges from the Project will be to the headwaters of Trimble Creek, Unnamed Creek (tributaries to the Embarrass River), and Second Creek (tributary to the Partridge River) in the St. Louis River watershed. Treated discharges from the WWTS will be split at SD001 to the three different receiving waters via Outfalls SD002-SD011 from the WWTS. The receiving waters for the discharges in the Embarrass River watershed are wetlands that drain to Trimble (i.e., SD004-SD010) and Unnamed (i.e., SD002-SD003) Creeks which are Class 2D, 3D, 4C, 5, and 6 waters. Trimble and Unnamed Creeks themselves are Class 2B, 3C, 4A, 4B, 5, and 6 waters. The receiving water for the discharge in the Partridge River watershed is the headwater segment of Second Creek (SD011), which is a Class 2B, 3C, 4A, 4B, 5, and 6 water. All the above-identified waters are located in the Lake Superior basin and are classified as Outstanding International Resource Waters (OIRWs). The nearest downstream restricted Outstanding Resource Value Water (ORVW) is Lake Superior. There are no downstream prohibited ORVWs.

Reasonable Potential Analysis Overview
Federal regulations require MPCA to evaluate the discharge to determine whether the discharge has the reasonable potential to cause or contribute to a violation of water quality standards. MPCA must use acceptable technical procedures when determining whether the discharge causes, has the reasonable potential to cause, or contributes to an excursion of an applicable water quality standard. This is commonly called a "reasonable potential" analysis. When reasonable potential is indicated, the permit must contain a water quality-based effluent limit (WQBEL) for that pollutant. This Fact Sheet discusses the review conducted for sulfate, copper, and other parameters of potential concern.

Since each of the three waters receiving the proposed Project discharge is either the headwater segment of a stream or wetlands at the headwaters of a stream, the protective receiving water 7Q10 flow rate for each of the discharge locations is 0.0 CFS. The 7Q10 flow rate is the lowest stream flow for seven consecutive days that would be expected to occur once in ten years. The receiving water flow rate of 0.0 CFS does not allow for any dilution when analyzing for reasonable potential to cause or contribute to a violation of water quality standards.

Sulfate
MPCA conducted a reasonable potential analysis for sulfate in the Project's proposed discharge from the WWTS. In the absence of actual effluent data (the facility is proposed at this point and is not actually built), MPCA considered the proposed point and nonpoint source controls, including the proposed wastewater treatment technologies, as recommended in Chapter 6.3.3 of the EPA's NPDES permit writer's manual. Specifically, the MPCA reviewed the following information in conducting its Reasonable Potential analysis:

(1) Estimated effluent quality reported on Form 2D as included in the "NPDES/SDS Permit Application, Volume III, October 2017 (updated)"
(2) WWTS design model outputs as described in Attachment H to the "Waste Water Treatment System: Design and Operation Report, v2, October 2017" (WWTS Report), cited as a reference in the NPDES/SDS permit application, and
(3) Final Pilot Testing Report, included as Attachment B to the WWTS Report

Form 2D

PolyMet reported on Form 2D that the estimated "maximum daily value" and the "average daily value" for sulfate in the discharge will be 10 mg/L and 9 mg/L or less respectively, for both Mine Year 1 and Mine Year 10. As is indicated in Form 2D (by use of Code 2), the source of these values is "estimates from other engineering studies" and specifically the "Waste Water Treatment System (WWTS) Discharge Treatment Targets" from Table 2-2 on page 84 of Volume III of the permit application.

WWTS Design Model Outputs

WWTS process modeling[1] conducted by PolyMet simulated flows of water and solute mass between treatment component units (i.e., physical processes) combined with chemical process simulation. Using the modeling, the various treatment components were combined into an overall process that was iteratively modeled, varying the process based on interim results, to select an optimal system configuration. One of the outcomes of the modeling was a determination of the optimal proportion of membrane types (i.e., reverse osmosis (RO) or nanofiltration (NF)) that would result in the treated effluent meeting the 10 mg/L sulfate treatment target.

Results of the process design modeling for sulfate are summarized in Table 3 which shows projected WWTS discharge concentrations for different mine years using both an annual average influent flow and a 90th percentile peak influent flow:

Table 3 - Results of Process Design Modeling for Sulfate at Average and Peak Flows

Year	WWTS Discharge Water Quality (Annual Average Flow)	WWTS Discharge Water Quality (P90 Peak Flow)
Mine Year 1	1.89 mg/L	1.89 mg/L
Mine Year 7	8.28 mg/L	8.28 mg/L
Mine Year 8	7.77 mg/L	7.77 mg/L
Mine Year 10	9.83 mg/L	9.84 mg/L

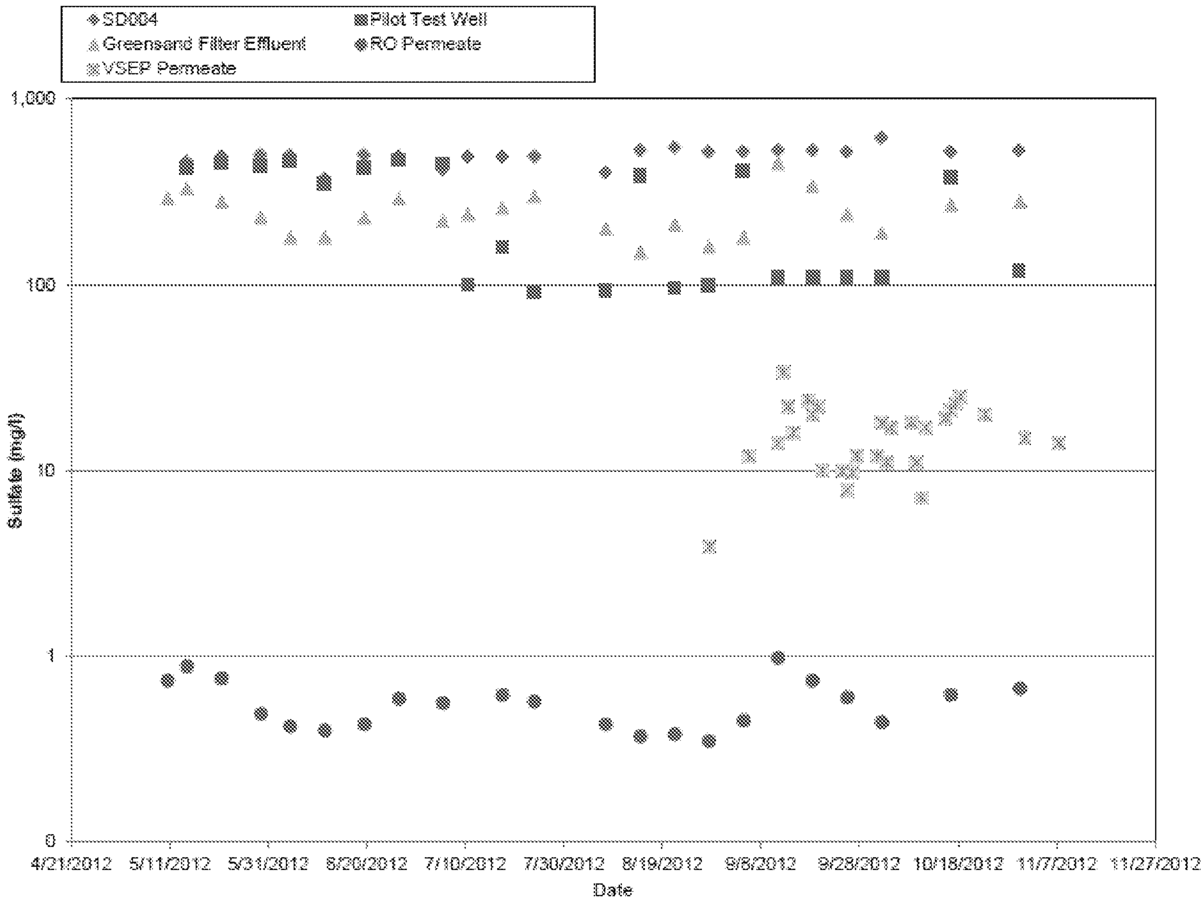
Projected WWTS discharge sulfate concentrations are very low in the first year of operation when there is little Project loading to the WWTS. Projected concentrations ramp up in later years when Project loadings increase. The design modeling takes into account these changes in the volume and quality of the wastewater that are expected to occur as the Project progresses from Mine Year 1 into later years and demonstrates that the proposed design can be optimized so the discharge will always be less than 10 mg/L sulfate. The design modeling results for select years (i.e., years when influent flows and/or concentrations are expected to noticeably change from the previous year) are shown in Table 3. Though not shown in the table above, projected WWTS discharge quality after Mine Year 10 remains in the 9 to 10 mg/L sulfate range.

[1] The process modeling was conducted utilizing 'GoldPHREEQC', which is a combination of two commonly used water quality modeling software packages, GoldSim and PHREEQC. GoldSim is used to simulate the physical processes such as the flow of water and solute masses between unit processes, and PHREEQC is used to simulate chemical processes such as solution reactions and equilibrium. As used in the process modeling for the Project, GoldPHREEQC considered the full range of Project flow and treatment conditions that were evaluated in the FEIS.

Pilot Test Results
To demonstrate that membrane treatment technologies are actually capable of achieving a 10 mg/L sulfate treatment target, PolyMet conducted a 6-month pilot testing program using seepage water from the existing tailings basin. For a portion of the test, additional metals were added to the test influent to more closely simulate projected influent quality. Pilot treatment system design included both RO and NF (in this case, "vibratory shear-enhanced process" or "VSEP") components.

Results of the pilot testing are shown in Figure 9 which is reproduced from the "Final Pilot Testing Report" (Appendix B of the "Waste Water Treatment System: Design and Operation Report, v2, October 2017").

Figure 9 – Sulfate Removal by the RO Process



The figure shows that influent for the pilot test, consisting of a mixture of tailings basin surface seepage collected from monitoring station SD004 (blue diamonds in the figure above) and groundwater seepage collected from a new well located at the toe of the basin near monitoring well GW006 (red squares), varied from approximately 100 to 500 mg/L sulfate. The figure also shows the permeate (i.e., effluent) concentration of both the RO and VSEP (NF) processes. Effluent from the RO process was consistently less than 1 mg/L sulfate (purple circles above) and the VSEP effluent was clustered in the 10-25 mg/L sulfate range (aqua-colored Xs). PolyMet will be operating both an RO circuit and an NF circuit at the WWTS and will blend the two permeates at a ratio based on actual concentrations to remain below the 10 mg/L Operating Limit. The blending of permeates to achieve an overall discharge concentration of

10 mg/L sulfate is proposed because of energy use considerations, reductions in the volume of concentrate, minimized cycling-up of rejected constituents and reduced membrane fouling.

Discussion

PolyMet has selected a combined water management and wastewater treatment system that will minimize or eliminate (i.e., to a level below method detection limit in most cases) pollutant loading to the receiving waters. The selected design utilizes the proven technologies of mechanical filtration followed by reverse osmosis and nanofiltration membrane filtration and has been demonstrated to be effective in project-specific pilot testing.

None of the receiving waters is subject to the Class 4A standard of 10 mg/L for sulfate, which applies to "water used for production of wild rice." Minn. R. 7050.0224 subp. 2. Based on information available at the time of the FEIS, including the recommended wild rice water listings made by MPCA staff in 2012 for certain portions of the Embarrass and Partridge Rivers, some waters downstream of the WWTS discharge might be considered "water used for the production of wild rice." These staff recommendations, however, were not enacted into any rule or otherwise finalized. Rather, MPCA has undertaken the wild rice studies mandated by the Legislature in its recent wild rice laws.

The Reasonable Potential analysis must consider the effect of dilution. 40 C.F.R. § 122.44(d)(1)(ii). The current wild rice sulfate standard is unique among Minnesota water quality standards in that it applies only in a "water used for the production of wild rice," without necessarily being limited to the receiving water or point of discharge. For scenarios where the standard might apply at some distance downstream from the discharge, the analysis must account for watershed dilution when assessing whether the discharge would exceed the standard at the downstream location. The existing wild rice rule does not specify the averaging period over which the sulfate standard applies, nor has MPCA developed a protocol for determining if a water is impaired with respect to this use. However, ongoing research conducted as part of the MPCA's standard revision process suggests that an appropriate averaging period for protecting the use of wild rice as a food source for wildlife and humans is a calendar year.

The issues above create uncertainties in conducting a Reasonable Potential analysis. In this case, however, the MPCA did not need to address these uncertainties because the projected effluent quality end-of-pipe at the WWTS will not exceed 10 mg/L and therefore will not cause an exceedance of the sulfate standard at downstream locations.

Specifically, the controlling design criterion for WWTS discharges is that the combined water management and treatment system consistently achieves a sulfate concentration of 10 mg/L or less in the discharge (Section 3.1.1 on pp. 19-20 of the Antidegradation Evaluation). The results of the design modeling and the pilot testing support the sulfate values reported in Form 2D. The results indicate that the treatment system will be designed and operated (including managing the proportion of RO to NF treatment) to consistently achieve a specified treatment target concentration. In this case, that target for sulfate is a performance Operating Target of 9 mg/L or less.

Membrane treatment technologies such as RO and NF work the same way as a micro-filter, in that a membrane has microscopic holes that allow the water molecules to pass through but retain the targeted constituent on one side of the membrane. This rejected water containing the concentrated constituents will be routed to the chemical precipitation treatment chain of the WWTS where the precipitation process results in the removal of the constituents from the system as a waste solid.

A membrane rejects molecules primarily based on molecular size and charge. As size and charge of the molecule increase, the membrane tends to reject the molecules to a greater extent. The properties of a membrane, such as the size of the pores, can be selected as part of treatment facility design to maximize removal of a particular constituent. In this case, the sulfate rejection rate across the membranes to be utilized in the WWTS was calculated to be >99% based on the results of pilot testing. Designing membrane treatment systems to achieve a specified effluent concentration is an established and reliable engineering process.

Because the maximum concentration of the discharge from the WWTS is projected to be no greater than 10 mg/L, and the annual average is projected to be 9 mg/L or less, there is no reasonable potential for the discharge to exceed the wild rice standard for sulfate regardless of where that standard may be applicable in any downstream waters. EPA's NPDES permit writer's manual states that if the projected effluent concentration is equal to or less than the applicable water quality standard, there is no reasonable potential and no need to require WQBELs for the discharge.

During the environmental review process, PolyMet committed to treating Project wastewater to 10 mg/L sulfate prior to discharge given the current wild rice rules and rulemaking process currently underway. This commitment to meet a 10 mg/L sulfate concentration in the discharge has been incorporated into the permit as an enforceable internal Operating Limit, which eliminates questions about applicability of the current wild rice standard at downstream locations. The commitment served as the basis for the water quality effects analysis in the FEIS. The incorporation of wastewater treatment technologies capable of achieving a 10 mg/L sulfate treatment level is a fundamental component of the overall Project design as evaluated in the FEIS and as described in the NPDES/SDS permit application; it is not a mitigation that was added as part of the permitting process.

To ensure the WWTS is operating as designed and to remain consistent with the assumptions made in the FEIS, the permit includes an internal performance monitoring point (Station WS074) where an Operating Limit of 10 mg/L sulfate applies. The Operating Limit at WS074 is an enforceable permit limit but is neither a water quality based effluent limit (because there is no "reasonable potential") nor a technology based effluent limit. Station WS074 will be located within the internal waste stream at a point after the permeates from the reverse osmosis and nanofiltration processes mix and prior to where the resulting blended effluent enters the stabilization process before it is discharged. Under the permit conditions, no sulfate may be added to the treated wastewater during the effluent stabilization process (i.e., between the internal monitoring point of WS074 and Outfall SD001). The Operating Limit for total sulfate is an enforceable permit condition, and if it were exceeded, it would be a violation of this permit.

As the FEIS discussed, if Minnesota adopts a revised wild rice standard, any subsequent Reasonable Potential analysis would have to be calculated using the revised standard. However, because the outcome of the wild rice rulemaking is not yet determined, MPCA's analysis has used the existing 10 mg/L sulfate standard. This is protective of any downstream locations where the standard may apply, and this analysis demonstrates that Project discharges do not have a reasonable potential to cause or contribute to a violation of the 10 mg/L sulfate standard for wild rice.

Copper

MPCA conducted a reasonable potential analysis for copper using the sources described above. Based on its review, the Agency has determined there is no reasonable potential for concentrations of copper to cause or contribute to an exceedance of any applicable water quality standards.

Form 2D
PolyMet reported on Form 2D of the permit application that the estimated copper concentration in the discharge from the WWTS would have a "maximum daily value" of 9.3 µg/L and an "average daily value" of 5.3 µg/L for Mine Year 1; and an estimated "maximum daily value" of 9.3 µg/L and an "average daily value" of 9 µg/L for Mine Year 10. EPA Form 2D indicates the source of these values is "estimates from other engineering studies" and specifically the "Waste Water Treatment System (WWTS) Discharge Treatment Targets" from Table 2-2 on page 84 of Volume III of the permit application.

WWTS Design Model Outputs
Copper was included as one of the evaluated constituents in the WWTS process modeling described for sulfate above. This modeling indicated that optimization of the treatment process for sulfate also resulted in effluent concentrations for copper well below applicable standards, as shown in the Table 4.

Table 4 - Copper Effluent Quality

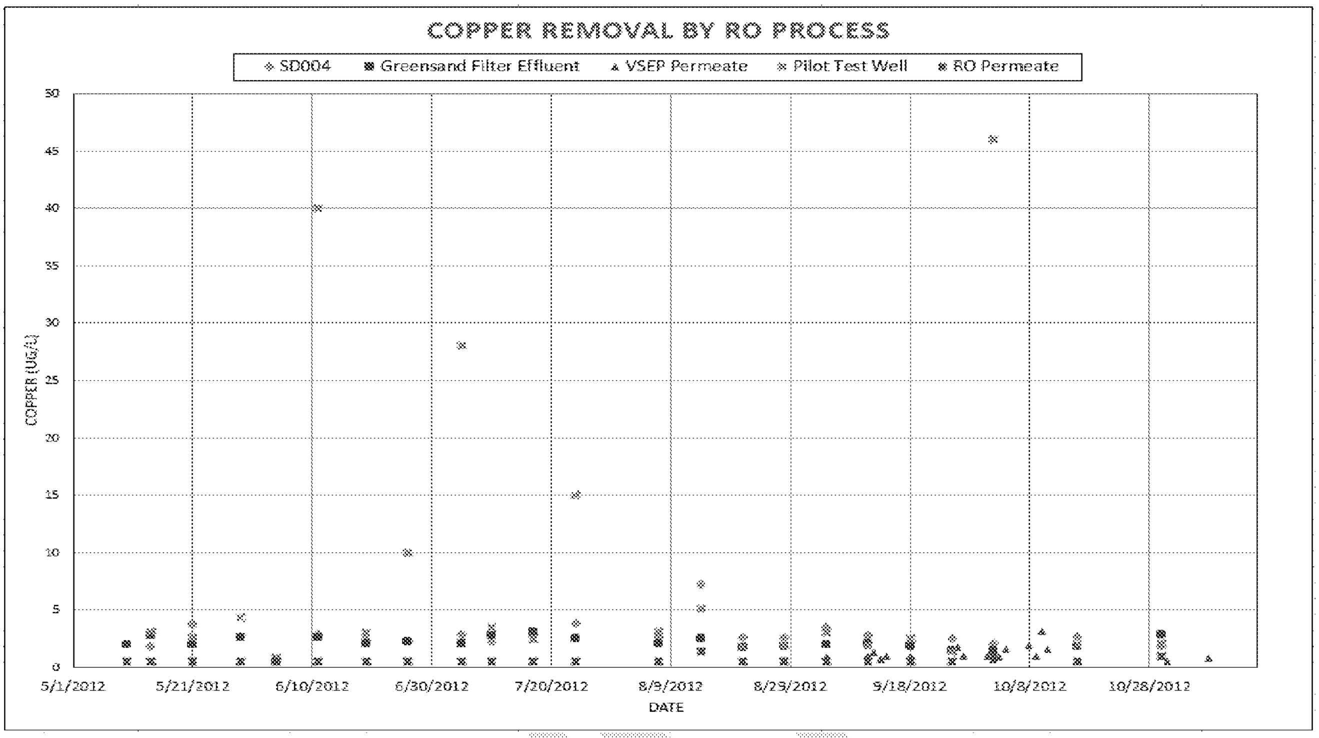
Year	Effluent Water Quality (Annual Average Flow)	Effluent Water Quality (P90 Peak Flow)
Mine Year 1	0.00657 µg/L	0.00657 µg/L
Mine Year 7	0.174 µg/L	0.174 µg/L
Mine Year 8	0.533 µg/L	0.533 µg/L
Mine Year 10	0.874 µg/L	0.874 µg/L
Water Quality Standard*	9.3 µg/L	9.3 µg/L

*At hardness = 100 mg/L

Pilot Test Results
PolyMet conducted a 6-month pilot testing program using seepage water from the existing tailings basin. For a portion of the test, additional metals were added to the test influent to more closely simulate projected influent quality. Pilot treatment system design included both RO and NF (In this case, "vibratory shear-enhanced process" or "VSEP") components.

Results of the pilot testing are shown in Figure 10, which is reproduced from data found in the "Final Pilot Testing Report" (Appendix B of the "Waste Water Treatment System: Design and Operation Report, v2, October 2017"). This is the same pilot testing used for the sulfate results described above, and the treatment was operated to meet the sulfate target of 10 mg/L.

Figure 10 - Copper Removal by RO Process



The figure shows that influent to the pilot test, consisting of a mixture of tailings basin surface seepage collected from monitoring station SD004 (blue diamonds in the figure above) and groundwater seepage collected from a new well located at the toe of the basin near monitoring well GW006 (orange colored X's), varied from approximately 0.5 µg/L to 46 µg/L copper. The figure also shows the permeate (i.e., effluent) concentration of both the RO and VSEP (NF) processes. Eighty-five percent of the results for copper in the RO effluent were less than the laboratory detection limit of 0.5 µg/L, and all detected values were less than 1.5 µg/L (blue colored X's above). Copper concentrations in the VSEP effluent were clustered in the 0.5 – 3.1 µg/L copper range (gray triangles). PolyMet will be operating both an RO circuit and an NF circuit at the WWTS and will blend the two permeates at a ratio based on actual concentrations to consistently meet the 10 mg/L sulfate treatment target, which was the target for the pilot testing described above. By meeting the 10 mg/L sulfate treatment target, the facility will also meet the 9.3 µg/L treatment target for copper as shown above.

Operating Limit for Copper

To ensure PolyMet operates its WWTS as proposed to meet an internal performance Operating Limit of 10 mg/L for sulfate, the Agency is requiring an internal performance monitoring station at Station WS074. (The Operating Limit for sulfate is further discussed in the Internal Performance Monitoring section of this Fact Sheet.) This internal monitoring station will be located within the WWTS at a point after the permeate streams from the RO and NF processes are blended and prior to effluent stabilization. The permit also includes a monthly average Operating Limit of 9.3 µg/L total copper at Station WS074. The Operating Limit is based on a projected hardness of approximately 100 mg/L in the effluent. No copper may be added to the treated wastewater during the effluent stabilization process (i.e., between the internal monitoring point of WS074 and Outfall SD001). This Operating Limit for total copper is an enforceable permit condition, and if it were exceeded, it would be a violation of this permit.

As described above, the analysis of copper showed there is no reasonable potential for copper to cause or contribute to an exceedance of water quality standards in the receiving waters, and therefore, there is no need to require WQBELs for the discharge. However, in addition to the internal Operating Limit at Station WS074, the permit contains federally-required Technology Based Effluent Limits (TBELs) relating to copper based on the New Source Performance Standards (NSPS) in 40 CFR § 440.104. The applicable TBEL under the NSPS is a daily maximum of 300 µg/L and a monthly average of 150 µg/L. at SD001.

Metals and Other Parameters of Concern

The degree of treatment necessary to accomplish an effluent concentration of 10 mg/L sulfate in the discharge from the WWTS will also result in the effective removal of other parameters of concern from the wastewater. As stated above, membrane treatment works the same way as a filter, in that a membrane has microscopic holes that allow the water molecules to pass through but retain the targeted constituent on one side of the membrane. A membrane rejects molecules primarily based on molecular size and charge. As size and charge of the molecule increase, the membrane tends to reject the molecules to a greater extent. The sulfate rejection rate across the membranes to be utilized in the WWTS was calculated to be >99% based on the results of pilot testing. The sulfate rejection rate is comparable to the rejection rate of other parameters of concern such as heavy metals because of their size and/or charge. Thus, treating sulfate to low levels (< 10 mg/L) will necessarily treat the other parameters of concern to low levels as well. So long as sulfate remains at or below 10 mg/L, the WWTS will ensure other parameters are discharged at below the projected design model concentrations.

MPCA conducted a reasonable potential evaluation for a variety of metals in addition to copper and for other parameters of concern, such as those subject to Class 3 and Class 4 water quality standards. As with sulfate and copper, the analysis indicated that there is no reasonable potential to exceed the water quality standard applicable to each parameter in the receiving waters. The design modeling values and the pilot testing results for all of the parameters of concern are below their respective water quality standards. See Table 4A. Therefore, no WQBELs are required for any of these metals or parameters of concern at Outfall SD001. However, for the metals with a projected influent at or above the applicable water quality standard, namely, arsenic, cobalt, lead, nickel and mercury, monthly average Operating Limits based on the Class 2B water quality standards have been included into the permit for monitoring point WS074 to ensure that actual WWTS removal efficiencies for these parameters are as expected. These Operating Limits are enforceable permit conditions, and if exceeded, would be a violation of the permit

Although the influent concentrations for arsenic, cobalt, lead and nickel are projected to be above the treatment target for each metal, the degree by which the influent is projected to exceed the target is much smaller than is projected for copper. In addition, their concentrations in the discharge as a percentage of their respective water quality standard are also less than for copper (see Table 4A). For these reasons, a provision prohibiting additions during the effluent stabilization process, similar to that for sulfate and copper, is not needed. Because influent concentrations of mercury are expected to be near the water quality standard, a provision prohibiting additions of mercury during the effluent stabilization is included in the permit.

The effluent stabilization process involves the use of an engineered, high purity calcite bed; the process is not proposing to use standard lime or limestone, which in some cases may have aluminum-containing impurities. To address potential concerns that the effluent stabilization process could add aluminum to the effluent, the permit prohibits the addition of aluminum to the effluent stabilization process.

For those parameters subject to federal categorical standards in 40 CFR Part 440 (i.e. copper, zinc, lead, mercury, cadmium, pH, total suspended solids, and arsenic), the applicable TBELs will be required at Outfall SD001.

Table 4A – WWTS Discharge: Influent Concentration vs. Expected Discharge (Design Model) Concentration

Parameter	Units	Influent Concentration	Treatment Target	Design Model Discharge Quality	Percent of Treatment Target
Aluminum (total)	µg/L	9.99	125	0.43	0.34%
Antimony (total)	µg/L	8.01	31	0.38	1.23%
Arsenic (total)	µg/L	24.30	10	0.004	0.04%
Boron (total)	µg/L	217.00	500	210	42.00%
Cadmium (total)	µg/L	1.26	2.5	0.056	2.24%
Chromium (total)	µg/L	6.04	11	0.31	2.82%
Cobalt (total)	µg/L	24.50	5	0.011	0.22%
Copper (total)	µg/L	395.00	9.3	0.87	9.35%
Lead (total)	µg/L	31.70	3.2	0.099	3.09%
Mercury	ng/L	1.0	1.3	<1.0	<77%
Nickel (total)	µg/L	344.00	52	0.14	0.27%
Selenium (total)	µg/L	1.96	5	0.046	0.92%
Silver (total)	µg/L	0.22	1	0.059	5.90%
Thallium (total)	µg/L	0.17	0.56	0.008	1.43%
Zinc (total)	µg/L	86.70	120	0.065	0.05%
Chloride	mg/L	24.5	230	23.4	10.17%
Hardness	mg/L	585	100	59.1	59.10%
pH	SU	7.4	6.5-8.5	8.4	N.A.
Sulfate	mg/L	337	10	9.84	98.40%

Proposed Permit Limits

Technology Based Effluent Limits

Minn. R. 7053.0225 subp. 1(A) states, in part, that point source dischargers of industrial or other wastes must comply with all applicable federal standards adopted by the EPA under sections 301, 306, and 307 of the Clean Water Act, United States Code, title 33, sections 1311, 1316, and 1317. Code of Federal Regulations, title 40, parts 401 through 469, are incorporated by reference.

Section 301 of the Clean Water Act requires particular categories of industrial dischargers to meet technology-based effluent limitation guidelines. Effluent limitation guidelines are national regulatory standards for wastewater discharged to surface waters and municipal sewage treatment plants. EPA issues these regulations for industrial categories, based on the performance of treatment and control technologies Technology-based effluent limitations (TBELs) require a minimum level of treatment of pollutants for point source discharges based on available treatment technologies, while allowing the discharger to use any available control technique to meet the limits. For industrial facilities, TBELs are derived by:

- Using national effluent limitations guidelines (ELGs) and standards established by EPA, and/or
- Using best professional judgement (BPJ) on a case-by-case basis in the absence of national guidelines and standards.

PolyMet is proposing to construct and operate a mine for copper-nickel-platinum-group elements (PGE) and associated processing facilities. The applicable ELG for the NorthMet Project is *40 CFR 440 – Ore Mining and Dressing Point Source Category*. EPA promulgated the Ore Mining and Dressing Effluent Guidelines and Standards (40 CFR Part 440) in 1975, and amended the regulation in 1978, 1979, 1982 and 1988. The regulation covers wastewater discharges from ore mines and processing operations. Regulations in Subpart J (Copper, Lead, Zinc, Gold, and Molybdenum), Subpart G (Nickel) and K (Platinum Ores) are applicable to the Project. Because NorthMet tailings will be deposited on top of existing taconite (iron ore) tailings, regulations in Subpart A (Iron) also apply to the Project.

New Source Performance Standards (NSPS) defined at CWA section 306 apply to direct dischargers. NSPS are technology-based standards for facilities that qualify as *new sources* as defined in 40 CFR § 122.2 and 40 CFR § 122.29. These standards reflect effluent reductions that are achievable based on the "best available demonstrated control technology." 40 CFR § 440.104 contains the NSPS for mines regulated under Subpart J. The project is also regulated under Subpart A, the iron ore subcategory, as an existing iron ore point source.[1] The Project is considered a new source for all categories except iron ore, and mine drainage discharged from SD001 via SD002 – SD011 is subject to the TBELs in 40 CFR § 440.104 and 40 CFR § 440.12.

For direct dischargers, best professional judgement (BPJ) may be used to establish technology-based limits or determine other appropriate means to control its discharge. BPJ is the method used to develop technology-based NPDES permit conditions on a case-by-case basis using all reasonably available and relevant data to establish technology-based limits or determine other appropriate means to control its discharge. It was determined upon review of the ELGs found in 40 CFR § 440, that Subpart G and Subpart K apply in addition to Subpart J and Subpart A discussed above, however, there are no NSPS for

[1] Even if the facility were treated as a new source in the iron ore subcategory, the technology-based limits would be identical. See 40 C.F.R. § 440.

Subparts G and K.

A summary of TBELs applicable to the proposed Project follows:

- Subpart J (copper, lead, zinc, gold, silver, and molybdenum ores): 40 CFR § 440.104 states facilities that qualify as new sources and are subject to New Source Performance Standards (NSPS) must achieve the NSPS representing the degree of effluent reduction attainable by application of the best available demonstrated technology (BADT). Effluent limits applicable to NSPS were evaluated and as a result, the permit contains TBELs for copper, lead, mercury, cadmium, pH, and total suspended solids based on Subpart J requirements.

- Subpart G (nickel ore): 40 CFR § 440.72 describes effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT). There are no NSPS for Subpart G. Effluent limits applicable to BPT were evaluated against the NSPS effluent limits required by Subpart J. As a result, the permit contains a TBEL for zinc and arsenic based on Subpart G requirements.

- Subpart K (platinum ore): 40 CFR § 440.113 describes effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT). There are no NSPS for Subpart K. Effluent limits applicable to BAT were evaluated against the NSPS effluent limits required by Subpart J. As a result, the permit contains a TBEL for zinc based on Subpart K requirements. (The TBEL for zinc required by Subpart K is the same as the TBEL required under Subpart G).

- Subpart A (iron ore): 40 CFR § 440.12 states that any existing point source must achieve effluent limitations representing the degree of effluent reduction attainable after application of the best practicable control technology currently available (BPT). Effluent limits applicable to BPT were evaluated and as a result, the permit contains a TBEL for dissolved iron, pH and total suspended solids based on Subpart A requirements.

The MPCA compared effluent characteristics for the Subpart J, Subpart G, Subpart K, and Subpart A categories. By using BPJ, the most stringent value for each parameter was chosen and will be the applicable TBEL for the discharge at SD001. A summary of the effluent characteristics for each subpart is found in Tables 5 and 6.

Table 5 - Summary of Effluent Characteristics for Subpart J, Subpart G and Subpart K Categories

Effluent Characteristic	Subp. J NSPS Mo. Avg (mg/L)	Subp. J NSPS Daily Max (mg/L)	Subp. G BPT Mo. Avg (mg/L)	Subp. G BPT Daily Max (mg/L)	Subp. K BAT Mo. Avg (mg/L)	Subp. K BAT Daily Max (mg/L)	Subp. A BPT Mo. Avg (mg/L)	Subp. A BPT Daily Max (mg/L)
Copper	0.15	0.30	0.15	0.30	0.15	0.30		
Zinc	0.75	1.5	0.5	1.0	0.5	1.0		
Lead	0.3	0.6	N/A	N/A	0.3	0.6		
Mercury	0.001	0.002	N/A	N/A	0.001	0.002		
Cadmium	0.05	0.10	0.05	0.10	0.05	0.10		
pH	*	*	*	*			*	*
TSS	20.0	30.0	20	30			20.0	30.0
Arsenic			0.5	1.0				
Dis. Iron							1.0	2.0

* 6.0 – 9.0 SU

The permit contains monthly average and daily maximum TBELs for the parameters listed below applicable to the discharge at SD001, after effluent stabilization. Monitoring of the effluent for these parameters is required once per week.

Table 6 - Applicable Categorical Technology Based Effluent Limitations

Substance or Characteristic	Calendar Month Average (mg/L)	Daily Maximum mg/L)	Basis for Limit (BAT,BCT,BPJ,BPT,NSPS)*
Copper	0.15	0.30	NSPS, BPT, BAT
Zinc	0.5	1.0	BPT, BAT, BPJ
Lead	0.3	0.6	NSPS, BPT, BAT
Mercury	0.001	0.002	NSPS, BAT
Cadmium	0.05	0.10	NSPS, BPT, BAT
pH	6.0 -	9.0	NSPS, BPT
TSS	20.0	30.0	NSPS, BPT
Arsenic	0.5	1.0	BPT, BPJ
Dis. Iron	1.0	2.0	BPT

*NSPS: 40 CFR 440.104; BPT: 40 CFR 440.72; BAT: 40 CFR 440.113 and/or 40 CFR 440.12

Comparison of Technology Based Effluent Limit to Equivalent Secondary Treatment Standards – TSS and pH

The effluent limitation for total suspended solids (TSS) is a technology based effluent limit contained in the NSPS as described in 40 CFR § 440.104. The maximum daily limit specified for total suspended solids is 30 mg/L. The monthly average effluent limit for total suspended solids is 20 mg/L. The equivalent state secondary treatment standard under Minn. R. 7053.0215 (as incorporated by Minn. R. 7053.0225) requires a maximum daily limit of 45 mg/L and a monthly average limit of 30 mg/L. The TBEL is more stringent than the state secondary standard; therefore, the average and maximum TBEL limits of 20 mg/L and 30 mg/L respectively apply.

The effluent limitation of 6.5 to 8.5 for pH are based on state water quality standards for Class 2B (aquatic resources) and Class 4A (agriculture and wildlife) waters, in accordance with Minn. R. 7050.0222 and Minn. R. 7050.0224, for effluent, which is the principal source contributing flow to the receiving waters (i.e. headwaters). The state water quality based effluent limitation of 6.5-8.5 is more stringent than the TBELs of 6.0 to 9.0 for pH set forth in 40 CFR § 440.72 and 40 CFR § 440.104; therefore, the 6.5-8.5 value is included as the pH limit in the permit for the effluent at SD001.

Comparison of Technology Based Effluent Limits to Water Quality Standards and Operating Limits - Metals

Copper

The MPCA conducted a reasonable potential analysis for copper as described in the Reasonable Potential section above. Based on its review, the Agency has determined there is no reasonable potential for concentrations of copper in the WWTS effluent to cause or contribute to an exceedance of water quality standards. However, to ensure the WWTS is removing copper as expected, an internal Operating Limit of 9.3 ug/L for total copper applies at Station WS074. The internal monitoring station will be established within the WWTS at a point located after the permeate streams from the reverse osmosis and the nanofiltration are blended and prior to effluent stabilization. No copper may be added to the treated wastewater during the effluent stabilization process (i.e., between the internal monitoring point of WS074 and Outfall SD001). The Operating Limit is based on a projected hardness of approximately 100 mg/L in the effluent. In addition to the internal Operating Limit at station WS074, the permit contains a TBEL for copper applicable at station SD001 based on the NSPS under 40 CFR § 440.104. The permit requires weekly monitoring of the effluent at stations WS074 and SD001 for total copper using EPA Method 200.8.

The applicable TBEL under the NSPS is a daily maximum of 0.30 mg/L and a monthly average of 0.15 mg/L.

Arsenic
The MPCA conducted a reasonable potential analysis for arsenic as part of the permit application review. Based on its review, the Agency has determined there is no reasonable potential for concentrations of arsenic in the WWTS effluent to cause or contribute to an exceedance of water quality standards. However, to ensure the WWTS is removing arsenic as expected, an Operating Limit of 53 ug/L total arsenic applies at station WS074, There is no applicable TBEL under the NSPS for arsenic as described in Table 2 above. A review of effluent limit requirements under 40 CFR § 440 Subpart G and Subpart K were conducted and compared to the NSPS under 40 CFR § 440.104. The review determined that TBELs for arsenic are applicable under 40 CFR § 440.72 by applying the best available technology economically achievable (BAT). Using best professional judgement (BPJ), the Agency determined the applicable TBEL for arsenic at station SD001 is a daily maximum of 1.0 mg/L and a monthly average of 0.5 mg/L. The permit requires weekly monitoring of the WWTS effluent at stations WS074 and SD001 for total arsenic using EPA Method 200.8.

Lead
The MPCA conducted a reasonable potential analysis for lead as part of the permit application review. Based on its review, the Agency has determined there is no reasonable potential for concentrations of lead in the WWTS effluent to cause or contribute to an exceedance of water quality standards. However, to ensure the WWTS is removing lead as expected, an Operating Limit of 3.2 ug/L total lead applies at station WS074, The Operating Limit is based on a projected hardness of approximately 100 mg/L in the effluent. In addition to the internal Operating Limit at station WS074, the permit contains a TBEL for lead applicable at station SD001 based on the NSPS under 40 CFR § 440.104. The permit requires weekly monitoring of the WWTS effluent at stations WS074 and SD001 for total lead using EPA Method 200.8. The applicable TBEL at station SD001 under the NSPS for lead is a daily maximum of 0.6 mg/L and a monthly average of 0.3 mg/L.

Mercury
The MPCA conducted a reasonable potential analysis for mercury as part of the permit application review. Based on its review, the Agency has determined there is no reasonable potential for concentrations of mercury in the WWTS effluent to cause or contribute to an exceedance of water quality standards. The MPCA expects no measurable change in mercury concentrations downstream in the St. Louis River at Forbes or below. However, to ensure the WWTS is removing mercury as expected, an Operating Limit of 1.3 ng/L total mercury applies at station WS074, The permit requires weekly monitoring of the WWTS effluent at stations WS074 and SD001 for total mercury using analytical method 1631 and clean-sampling method 1669. The applicable TBEL at station SD001 under the NSPS for mercury is a daily maximum of 0.002 mg/L and a monthly average of 0.001 mg/L.

Cadmium
The MPCA conducted a reasonable potential analysis for cadmium as part of the permit application review. Based on its review, the Agency has determined there is no reasonable potential for concentrations of cadmium in the WWTS effluent to cause or contribute to an exceedance of water quality standards. Because the influent to the WWTS is expected to be below the applicable water quality standard, an Operating Limit for cadmium is not included in the permit. The permit requires weekly monitoring of the WWTS effluent at station SD001 for total cadmium using EPA Method 200.8. The applicable TBEL at station SD001 under the NSPS for cadmium is a daily maximum of 0.10 mg/L and a monthly average of 0.05 mg/L.

Zinc
The MPCA conducted a reasonable potential analysis for zinc as part of the permit application review. Based on its review, the Agency has determined there is no reasonable potential for concentrations of zinc in the WWTS effluent to cause or contribute to an exceedance of water quality standards. Because the influent to the WWTS is expected to be below the applicable water quality standard, an Operating Limit for cadmium is not included in the permit. There is no applicable TBEL under the NSPS for zinc as described in Table 2 above. A review of effluent limit requirements under 40 CFR § 440 Subpart G and Subpart K were conducted and compared to the NSPS under 40 CFR § 440.104. The review determined that applicable TBELs for application of the best practicable control technology currently available (BPT) are required for zinc under 40 CFR § 440.72 and 40 CFR § 440.113. Using best professional judgement (BPJ), the Agency determined the applicable TBEL at station SD001 for zinc is a daily maximum of 1.0 mg/L and a monthly average of 0.5 mg/L. The permit requires weekly monitoring of the WWTS effluent at station SD001 for total zinc using EPA Method 200.8.

Dissolved Iron
There is no applicable water quality standard for dissolved iron in Minnesota Rules. Therefore, no reasonable potential analysis for dissolved iron was conducted. The permit requires weekly monitoring of the WWTS effluent at station SD001 for dissolved iron. The applicable TBEL at station SD001 under application of BPT as required by 40 CFR § 440.12 for dissolved iron is a daily maximum of 2.0 mg/L and a monthly average of 1.0 mg/L.

The TBELs identified above are included in the permit to satisfy the requirements of 40 CFR Part 440. They are not intended to, nor do they, guarantee compliance with Minnesota water quality standards. As discussed in several sections above, MPCA conducted a reasonable potential analysis for a wide range of parameters and for each parameter found no reasonable potential for the WWTS effluent to cause or contribute to an exceedance of water quality standards. Therefore, no WQBELs are required for Outfall SD001. However, to provide additional assurance that the discharge will not violate water quality standards and to ensure the enforceability of the permit, a provision has been included in the permit that states that the discharge of treated wastewater from the WWTS must not violate state water quality standards. Additionally, a reopener clause has been included in the permit that specifically identifies that the MPCA may modify the permit, require corrective actions, or take other actions if it determines that a discharge authorized by this permit is causing or contributing to a violation of water quality standards.

Internal Performance Monitoring

Sulfate and Metals Internal Performance Evaluation Point
As described above, MPCA has determined that there is no reasonable potential for sulfate or metals to cause or contribute to a violation of a water quality standard, and is not establishing WQBELs for these parameters. However, PolyMet has agreed to use sulfate and certain metals, particularly copper, as indicator parameters for ongoing evaluation of the performance of the WWTS tailings basin seepage treatment train as explained in more detail in Application Volume I, Appendix D. By meeting its treatment targets for sulfate and metals, PolyMet will be able to assure that the discharge will have no such reasonable potential for any parameters of potential concern.

To facilitate this approach to evaluating the performance of the WWTS, Operating Limits for sulfate and certain metals are included in the permit. PolyMet will be required to sample for sulfate and metals with influent concentrations exceeding water quality standards at an internal performance monitoring point established within the WWTS located after the permeate streams from the reverse osmosis and the nanofiltration membranes are blended and prior to effluent stabilization (monitoring station WS074). These details are discussed below.

Sulfate
The Project WWTS will eliminate (i.e., to a level below the method detection limit) or minimize pollutant loading to the receiving waters. The removal of sulfate is the controlling factor in the treatment system design. The WWTS incorporates membrane treatment technology (a combination of nanofiltration and reverse osmosis) designed to achieve an effluent concentration of 10 mg/L sulfate or less.

The MPCA conducted a reasonable potential analysis for sulfate in the Project's proposed discharge from the WWTS. In the absence of actual effluent data (the facility is proposed at this point and is not actually built), the MPCA considered the proposed point and nonpoint source controls including the treatment technologies selected. Specifically, the following information was reviewed: 1) estimated effluent quality reported on Form 2D in the "NPDES/SDS Permit Application, Volume III, October 2017 (updated)"; 2) WWTS design model outputs as described in Attachment H to the "Waste Water Treatment System: Design and Operation Report, v2, October 2017" (WWTS Report) cited as a reference in the NPDES/SDS Permit Application dated October 2017; and 3) the Final Pilot Testing Report, included as Attachment B to the WWTS Report for the proposed project. The MPCA determined there is no reasonable potential for the discharge to cause or contribute to an exceedance of an applicable sulfate standard, and therefore, no justification for a WQBEL for sulfate to be included in the permit. By treating sulfate levels to 10 mg/L or less, all other parameters will be treated to concentrations less than their respective water quality standard. The design values for parameters of concern as indicated in the permit application based on modeling data and pilot test data will be consistently below the water quality standards. See Table 4A above.

The WWTS design to treat discharges to a concentration level of 10 mg/L for sulfate was included in the environmental effects analysis described in the FEIS. To ensure the WWTS is operating as designed and to remain consistent with the assumptions of the FEIS, the permit includes an internal performance monitoring point at Monitoring Station WS074 where an Operating Limit of 10 mg/L sulfate applies.

The Operating Limit at WS074 is an enforceable permit limit but is neither a WQBEL nor a TBEL but is an enforceable internal performance metric within the WWTS. To effectively monitor the degree and quality of wastewater treatment afforded by the membrane technologies, Station WS074 will be located within the internal waste stream at a point after the permeates from the reverse osmosis and nanofiltration processes mix and prior to where the resulting blended effluent enters the stabilization process before it is discharged. This point within the treatment system flowsheet is immediately after the treatment processes that result in the removal of sulfate and is therefore representative of the water entering the stabilization process. The permit contains a prohibition against adding sulfate during the subsequent effluent stabilization process and a requirement that this be certified on the monthly Discharge Monitoring Reports. Conformance with the Operating Limit will be determined by an average of the previous 12-monthly averages. Based on research from MPCA's work in connection with the proposed revisions to the wild rice sulfate water quality standard, this averaging period is protective against longer-term chronic effects to wild rice (Statement of Need and Reasonableness: proposed amendment of the sulfate water quality standard applicable to wild rice and identification of wild rice waters. Minn. R. ch. 7050 and 7053, July 2017).

To ensure that the Operating Limit of 10 mg/L is not exceeded, the permit will also include an internal Operating Target value at Station WS074 of 9 mg/L as determined by a monthly average. The Operating Target value is defined as an intervention metric that triggers adaptive management as defined in a pre-approved Sulfate Reduction Evaluation Plan to ensure that the Operating Limit of 10 mg/L is not exceeded. The Sulfate Reduction Evaluation Plan must be approved by MPCA before operation and discharge from the WWTS.

Copper and Other Metals

A reasonable potential analysis was conducted for a wide range of metals (aluminum, arsenic, antimony, boron, cobalt, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium and zinc) based on available data submitted with the permit application. This information included estimated effluent quality data reported in EPA Form 2D, results from the pilot testing of the proposed wastewater treatment technology, modeling projections from the FEIS and design engineering modeling conducted after the FEIS. Based on the available data, there is no reasonable potential for the discharge to cause or contribute to an exceedance for any of the metals, including copper. Therefore, there is no justification for a WQBEL for copper or other metals to be included in the permit. A more thorough discussion of the reasonable potential evaluation process as it is applied to the Project's discharge can be found in the Reasonable Potential section of this Fact Sheet above.

As described above, the WWTS is designed to treat sulfate to a concentration of 10 mg/L or less. The degree of treatment necessary to accomplish an effluent concentration of 10 mg/L sulfate will also result in the effective removal of other parameters of concern, including metals, to concentrations below their respective water quality standards. As described in the Reasonable Potential section of this Fact Sheet, treating sulfate to low levels (10 mg/L or less) will treat many other parameters of concern to low levels as well. However, to provide assurance of this result, the permit also includes an internal performance Operating Limit for certain metals, including total copper. Copper is of particular interest in this analysis based on the waste rock characterization and wastewater modeling projections conducted for the Project. Because this is a copper mine, concentrations in the internal wastewater stream relative to the applicable water quality standard are expected to be greater for copper than a similar comparison for other metals. The WWTS membrane technologies employ similar removal processes and efficiencies for copper as they do for other metals with less sensitive water quality standards. See Table 4A above. However, to ensure the WWTS performs as expected and does sufficiently remove these other metals, Operating Limits at the internal monitoring point WS074 for those metals with influent concentrations at or greater than their respective water quality standard (namely, arsenic, cobalt, nickel, lead and mercury) are also included in the permit.

Proposed Monitoring Group Summary

Monitoring Group Summary

For the purposes of providing an overall summary of the water quality monitoring required by the permit, the parameters to be monitored at the various locations at the Mine and Plant Sites can be generally categorized into three monitoring groups: Group A, Group B and Group C. The selection of which group of parameters would be required at individual monitoring locations was based on the expected nature of the water to be monitored and the purpose of the monitoring. These three groups of parameters are not necessarily uniformly applied and certain parameters are added or deleted from each group based on the specific characteristics and purpose of the individual monitoring location.

- *Group A Monitoring Summary*
  Group A parameters were selected because they are generally indicative of mining activities. The purpose of Group A monitoring is to facilitate more frequent monitoring of a focused group of parameters at certain key locations to identify potential water quality impacts in the most timely manner practicable. If potentially problematic results are seen, additional monitoring can be conducted as appropriate. Group A parameters include chloride, sulfate, specific conductance, and total dissolved solids and are summarized in Table 7.

Table 7 - Group A Monitoring Parameters

Parameters
Chloride
Specific Conductance
Sulfate
Total Dissolved Solids (TDS)

- *Group B Monitoring Summary*
  Group B parameters consist of those with TBEL requirements specified in 40 CFR part 440 as well as those subject to Class 3 & 4 water quality standards in Minnesota Rule 7050.0223 and 7050.0224. Group B monitoring also includes additional parameters of interest particular to the Project. The list of Group B parameters is intended to include those parameters that are expected to be monitored routinely for the purpose of assessing facility compliance and potential impacts. A summary of typical Group B parameters is listed in Table 8.

Table 8 - Group B Monitoring Parameters

ELGs	Class 3 & 4	Other/Indicator
Arsenic	Chloride	Aluminum
Cadmium	Bicarbonate	Calcium
Copper	Hardness	Cobalt
Lead	Specific Conductance	Magnesium
Mercury	Sulfate	Nickel
pH	Total Dissolved Solids (TDS)	
Total Suspended Solids (TSS)		
Zinc		

- *Group C Monitoring Summary*
  Group C parameters consist of the Group B parameters plus additional metals and other inorganic pollutants. The Group C parameters include a wider list of metals for which less frequent monitoring is appropriate. A summary of typical Group C parameters is listed in Table 9.

Table 9 – Group C Monitoring Requirements

ELGs	Class 3 & 4	Metals & Inorganics
Arsenic	Chloride	Antimony
Cadmium	Bicarbonate	Aluminum
Copper	Boron	Beryllium
Lead	Hardness	Boron
Mercury	Specific Conductance	Calcium
pH	Sulfate	Chromium
Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)	Cobalt
Zinc		Fluoride
		Magnesium
		Manganese
		Nickel
		Selenium
		Silver
		Sodium
		Thallium

Wastewater Treatment System Monitoring

The WWTS will be located at the Plant Site and will house the process equipment for two separate treatment trains known as the mine water treatment trains and the tailings basin seepage treatment train. The primary components of the WWTS for the Project will include the Equalization Basin Area located at the Mine Site, the Mine to Plant Pipelines (MPP), and the WWTS building and associated Pretreatment Basin. A total of 17 monitoring points are associated with the WWTS.

WWTS – Surface Water Discharge Monitoring

The compliance monitoring location for the discharge from the WWTS is located at SD001. As discussed in the Technology Based Effluent Limit Section of this Fact Sheet, the permit contains monthly average and daily maximum Technology Based Effluent Limits at SD001 for the parameters listed in Table 10.

Table 10 - Applicable Categorical Technology Based Effluent Limitations

Substance or Characteristic	Calendar Month Average (mg/L)	Daily Maximum (mg/L)
Copper	0.15	0.30
Zinc	0.5	1.0
Lead	0.3	0.6
Mercury	0.001	0.002
Cadmium	0.05	0.10
pH	6.0 SU -	9.0 SU
TSS	20.0	30.0
Arsenic	0.5	1.0
Dis. Iron	1.0	2.0

Weekly monitoring for Class 3 & 4 parameters as well as nickel is also required at SD001. The permit requires monthly monitoring for Group C parameters.

The effluent is split at SD001 to three different receiving waters via a total of 10 separate outfalls. Effluent from SD001 flows to the headwater wetlands of Unnamed Creek via SD002 and SD003. The headwater wetlands of Trimble Creek receive effluent from SD001 via outfalls SD004 – SD010. The effluent also flows to the headwaters of Second Creek via SD011. Monitoring of the flow to each of these stations is required monthly where monthly average, daily maximum, and monthly flows are required to be reported.

WWTS – Internal Waste Stream Monitoring

Monitoring at internal monitoring points is required at the WWTS. The monitoring is focused on internal waste streams collected at the various WWTS components prior to and after treatment and provides information on quality and sources of wastewater into the WWTS. The internal waste stream monitoring can be categorized into the following groups:

- Internal Performance Monitoring Point
- Influent to WWTS (from FTB Seepage Capture Systems)
- Influent to WWTS (Low Concentration Mine Water)
- Influent to WWTS (High Concentration Mine Water)
- Effluent from Mine Water Treatment System (Chemical Precipitation Treatment Train)
- Effluent from Mine Water Treatment System (Membrane Filtration Treatment Train)

Internal Performance Monitoring Point
An internal performance monitoring point at Station WS074 has been established in the permit to ensure the WWTS is operating as designed. This station is located at a point after the permeate streams from the reverse osmosis and nanofiltration membranes are blended and prior to effluent stabilization. Monitoring will be required once per week for sulfate, copper, arsenic, nickel, cobalt, lead and mercury. As discussed above, Operating Limits for each of these parameters have been assigned to station WS074.

Further discussion on the internal performance monitoring point, as well as the Operating Limits for total sulfate and total metals can be found in the Reasonable Potential section of this Fact Sheet.

WWTS Influent – FTB Seepage Capture Systems
The WWTS receives flow from the FTB Seepage Containment System and the FTB South Seepage Management System and is monitored at WS015. The permit requires monitoring of the WWTS influent weekly for Group B parameters to determine the influent quality of wastewater coming into the WWTS. Monthly monitoring is required for Group C parameters.

WWTS Influent – Low Concentration and High Concentration Mine Water
Two equalization basin systems will be in place at the Mine Site. Higher strength waste streams will be directed to one system, and lower strength waste streams into the other. Water quality will be monitored prior to the contents being routed to the WWTS for treatment. Monitoring of the influent of the Low Concentration Equalization (LCEQ) Basins and High Concentration Equalization (HCEQ) Basin will be done at WS415 and WS416 respectively. Monitoring of the influent for Group B parameters is required once per month at the combined LCEQ Basins and at the HCEQ Basin. Monitoring for Group C parameters is required twice per year.

WWTS Mine Water Treatment Effluent
Two separate treatment trains will treat mine water prior to discharge to the FTB. The Chemical Precipitation Treatment Train will treat mine water from the High Concentration Equalization Basin, and the Membrane Filtration Treatment Train will treat mine water from the Low Concentration Equalization Basins. Effluent from the Chemical Precipitation Treatment Train and the Membrane Filtration Treatment Train will be monitored at Stations WS072 and WS073 respectively for Group B parameters once per month and Group C parameters twice per year.

Mine Site Monitoring
Water quality and/or water level monitoring at a total of 102 monitoring locations at the Mine Site is required by the permit. A complete list of Mine Site monitoring for internal waste stream monitoring stations, groundwater monitoring stations, and surface water monitoring stations along with maps showing their locations is located in Attachment 1 of this Fact Sheet. A summary of the proposed monitoring requirements at the Mine Site is provided below.

Mine Site – Internal Waste Stream Monitoring Summary
Monitoring at internal monitoring points will be required at the Mine Site. This monitoring is focused on internal waste streams collected from Mine Site features prior to treatment and provides information on the quality and sources of wastewater at the Mine Site. The internal waste stream monitoring can be categorized into the following groups:

- Mine Pit Dewatering
- Waste Rock Stockpiles

- Ore Surge Pile
- Overburden Storage and Laydown Area (OSLA)
- Construction Mine Water Basin

Mine Pit Dewatering:
Monitoring of the mine pit dewatering water will take place at a total of four mine pit dewatering sumps located at the Mine Site. The Mine Site mine pit monitoring includes dewatering locations found at the East Pit, West Pit (two locations depending on mine year), and the Central Pit. The Mine Site dewatering water is routed to the Equalization Basin Area and is required to be monitored twice per month for the Group B parameters.

Waste Rock Stockpiles:
Stockpile drainage collected at the permanent Category 1 Waste Rock Stockpile sumps and ponds and the temporary Category 2/3 and Category 4 Waste Rock Stockpiles sumps and ponds is routed to the Equalization Basin Area. Drainage from each of these stockpiles is required to be monitored twice per month for chloride, copper, hardness, nickel, pH, specific conductance, sulfate, and total dissolved solids. Monthly monitoring is required at each of these areas for Group B parameters.

Ore Surge Pile:
Drainage collected at the Ore Surge Pile is routed to the Equalization Basin Area and is required to be monitored twice per month for chloride, copper, hardness, nickel, pH, specific conductance, sulfate, and total dissolved solids. Monthly monitoring is required at each of these areas for Group B parameters.

Overburden Storage & Laydown Area (OSLA) and Construction Mine Water Basin:
Monitoring of runoff collected at the OSLA will be monitored for Group A parameters once per month. Because the OSLA and Construction Mine Water Basin will store materials that are not expected to release harmful constituents, a reduction in the parameter list from what is monitored at other stockpile locations is appropriate.

Mine Site – Groundwater Monitoring Summary
The permit requires monitoring of the groundwater at the Mine Site as well as areas downgradient of the Mine Site. The groundwater monitoring well network at the Mine Site has been designed to gather sufficient groundwater quality and groundwater elevation data to assess the performance of the Project engineering controls and the Project's potential for impact to groundwater resources during both operation and reclamation/closure. The groundwater data will also be used to help predict the potential for impact to surface waters of the State which the groundwater may affect. The Mine Site groundwater monitoring well network consists of 78 monitoring devices located in and around Mine Site facilities. The monitoring network includes 43 surficial aquifer monitoring wells (surficial aquifer meaning the uppermost groundwater aquifer, contained within the unconsolidated materials above the bedrock surface), 21 bedrock aquifer monitoring wells and 14 piezometers (for groundwater elevation l measurements within the surficial aquifer) which can be categorized into the following groups:

- Category 1 Stockpile Groundwater Containment System Wells & Piezometers
- Surficial Aquifer Wells
- Bedrock Wells
- North Flow Path Wells

Category 1 Stockpile Groundwater Containment System Wells & Piezometers:
The performance of the Groundwater Containment System surrounding the Category 1 Waste Rock Stockpile will be monitored using paired monitoring devices located along the containment system at

the toe of the stockpile. Each monitoring pair will include one device located on the inward side of the containment system and one on the outward side. The monitoring system will include alternating pairs of monitoring wells (from which water quality and water level samples can be obtained) and piezometers (for water level measurements only). The water level data will be used to confirm that an inward hydraulic gradient is maintained, thereby demonstrating that no leachate is leaving the stockpile groundwater containment system and entering the surficial aquifer. Water quality data will be used to compare the water chemistry from the inside of the containment system to the outside and will serve as an early indicator of any potential release of contaminants to the surrounding groundwater. Together, the Groundwater Containment System monitoring network will consist of 12 surficial aquifer monitoring wells (6 pairs) and 14 piezometers (7 pairs). The monitoring wells will be installed in the surficial aquifer and are required to be monitored monthly for water level and quarterly for Group A parameters.

Surficial Aquifer and Bedrock Wells:
The performance of the engineered liner systems under the temporary Category 2/3 and Category 4 Waste Rock Stockpiles, the Ore Surge Pile (OSP), and the Equalization Basins will be monitored by a total of 6 surficial aquifer monitoring wells. Each well will be immediately downgradient of these facilities, including 3 wells downgradient of the Category 2/3 Stockpile, one well downgradient of the Category 4 Stockpile, one well downgradient of the OSP, and one well downgradient of the Equalization Basins. Water quality data from these wells, in conjunction with water quality and water volume data collected from stockpile sumps, will be monitored quarterly for Group B parameters and annually for Group C parameters. The groundwater quality will be assessed to confirm that the engineering controls are operating properly and that there are no adverse effects on groundwater. The location of these wells immediately downgradient of the facilities will provide early indication of a potential release.

In addition to the engineered systems performance monitoring, groundwater quality downgradient of the active portion of the Mine Site will be monitored by a series of 23 surficial aquifer monitoring wells, including the 6 surficial aquifer monitoring wells used for performance monitoring. Approximately half of these wells will be located relatively close in to the active mining areas (e.g., along Dunka Road) with the other half being located at or near the downgradient property boundary. Water quality will be monitored quarterly for Group B parameters and annually for Group C parameters. Water quality data from the surficial aquifer wells more proximal to Mine Site features will provide assurance that contaminants from the Project do not reach adjacent downgradient surface waters, as well as provide early identification of potential problems such that adaptive management or mitigation can be implemented if needed. Data from the wells at the property boundary will be used to help assess compliance with applicable groundwater standards.

A total of 10 bedrock water quality monitoring wells will be installed at the Mine Site. The bedrock monitoring wells will monitor groundwater downgradient of various Mine Site features and are located along similar flow paths as the surficial aquifer wells. The bedrock aquifer monitoring wells will be monitored quarterly for Group B parameters and annually for Group C parameters.

North Flow Wells:
The FEIS identified that groundwater flow through the bedrock aquifer to the north (north of the Partridge River towards the Peter Mitchell Mine) during the post-closure period was not likely to occur but could not be ruled out. Although such northward flow, if it were to occur at all, would not happen until at least 20 years into the post-closure period (i.e., after the West Pit refills) the FEIS recommended that Project permits include monitoring that would provide the data necessary to make decisions on adaptive management or mitigation that could be designed, permitted and implemented prior to any north flow actually occurring. To assess the potential for a north flow path, and to provide the information needed to model or predict whether such flow would occur, groundwater elevation (water

level) will be monitored monthly using a series of 11 bedrock aquifer monitoring wells and 8 surficial aquifer monitoring wells. These wells will be located along two general transects, one from the Project East Pit to the more eastern Peter Mitchell Pits and one from the Project West Pit to the more western Peter Mitchell Pits. The results of the north flow well monitoring will be analyzed and compiled in a report to be submitted as part of the Annual Groundwater Evaluation Report. Future monitoring recommendations for the north flow wells will be made upon permit reissuance.

Monitoring Parameters and Monitoring Frequency:
The parameters and frequency of monitoring for each category of monitoring device depends on the location and specific purpose of the monitoring. In general, monitoring parameters and frequency utilize a tiered approach with more frequent monitoring of key indicator parameters in conjunction with less frequent monitoring of a wider range of parameters. Key indicator parameters with quarterly monitoring includes, at most locations, arsenic, bicarbonate, calcium, chloride, copper, hardness, magnesium, manganese, nickel, pH, specific conductance, sulfate, total dissolved solids, and water levels. The wider list of parameters to be monitored annually at most locations includes relevant metals and inorganic constituents. The quarterly and annual monitoring frequencies for water quality sampling are sufficient due to the very slow flow velocities of groundwater at the site (on the order of a few to tens of feet per year). Monthly monitoring of water levels at the Category 1 Stockpile groundwater containment system is being required to provide timely assessment of system performance. The Mine Site groundwater monitoring network is summarized in Table 11.

Table 11 - Mine Site Groundwater Monitoring Summary

Type	Number of Locations	Frequency	Parameter List	Notes	Station Numbers
Category 1 Stockpile Groundwater Containment System (Water Levels)	14	Monthly	Water Level only	7 sets of paired piezometers	GW600 – GW625*
Category 1 Stockpile Groundwater Containment System (Water Quality)	12	Quarterly	Group A(1)	6 sets of paired monitoring wells	GW600 – GW625*
Surficial Aquifer Wells (Water Quality)	23	Quarterly Annually	Group B(2) Group C(3)		GW402 – GW495*
Bedrock Monitoring Wells (Water Quality)	10	Quarterly Annually	Group B(2) Group C(3)		GW501 – GW516 GW524 – GW525
Monitoring Wells (North Flow)	19	Monthly	Water Level only	11 Bedrock wells, 8 surficial wells	GW504 – GW523* GW470 – GW499*

*Gap in monitoring station sequence

(1) Group A Monitoring key indicator parameters include. Chloride, specific conductance, sulfate, total dissolved solids and water levels.
(2) Group B Monitoring parameters of interest include: Arsenic, bicarbonate, calcium, chloride, copper, hardness, magnesium, manganese, nickel, pH, specific conductance, sulfate, total dissolved solids, and water levels.
(3) Group C Monitoring parameters of interest include: Aluminum, antimony, beryllium, barium, cadmium, chromium, cobalt, fluoride, lead, selenium, thallium, and zinc.

Mine Site – Surface Water Monitoring Requirements (Summary)
Monitoring of nearby surface waters at nine locations will be required at the Mine Site. The Mine Site

surface water monitoring stations are categorized into two groups:

- Background surface water monitoring
- Downstream surface water monitoring

Background Surface Water Monitoring
A total of four surface water monitoring stations will be located upstream of the Mine Site:

- Partridge River – upstream of the Mine Site at SW002
- Wyman Creek – upstream of the Transportation and Utility Corridors at PM-6B
- Longnose Creek – upstream of the Transportation and Utility Corridors at LN-2
- Wetlegs Creek – upstream of the Transportation and Utility Corridors at WL-2

Monitoring of the upstream background monitoring stations will be used to establish background/baseline conditions at the Mine Site against which downstream monitoring can be compared. Monitoring of the upstream stations will be required monthly for Group B parameters and twice per year for Group C parameters.

Downstream Surface Water Monitoring
A total of five surface water monitoring stations will be located downstream of the Mine Site:

- Partridge River – downstream of the Mine Site at SW004c
- Wyman Creek – downstream of the Transportation and Utility Corridors at PM-5
- Longnose Creek – downstream of the Transportation and Utility Corridors at LN-1
- Wetlegs Creek – downstream of the Transportation and Utility Corridors at WL-1
- 'West Pit Outlet Creek' - downstream of the Transportation and Utility Corridors at WP-1.

Monitoring of the downstream monitoring stations will be used to establish background/baseline conditions at the Mine Site prior to mining operations and to monitor potential Project impacts once mining operations begin. Monitoring of the downstream monitoring stations will be required monthly for Group B parameters and twice per year for Group C parameters.

Plant Site Monitoring
Water quality and/or water level monitoring at a total of 67 monitoring locations at the Plant Site is required by the permit. A complete list of Plant Site monitoring for surface water discharge monitoring stations, internal waste stream monitoring stations, groundwater monitoring stations, and surface water monitoring stations along with maps showing their locations is located in Attachment 1 of this Fact Sheet. A summary of the proposed monitoring requirements at the Plant Site is provided below.

Plant Site – Internal Waste Stream Monitoring
Monitoring at internal monitoring points will be required at the Plant Site. This monitoring is focused on internal waste streams collected from Plant Site features prior to treatment and provides information on the quality and sources of wastewater at the Plant Site. The internal waste stream monitoring can be categorized into the following groups:

- Flotation Tailings Basin (FTB)
- Hydrometallurgical Residue Facility (HRF)
- Sewage Treatment Stabilization Ponds

Flotation Tailings Basin (FTB)
The permit has three internal monitoring stations at the FTB, which include monitoring of the FTB Pond water, the FTB Seepage Containment System, and the FTB South Seepage Management System. Wastewater from various sources at the Mine Site, the FTB Seepage Containment system, the Beneficiation Plant, the domestic sewage treatment system and filter backwash from the WWTS is routed to the mine site high-strength membrane treatment system. Monitoring of FTB Pond water quality is required monthly at Station WS001 for Group B parameters and twice per year for Group C parameters.

Monitoring of water quality of the collected seepage being routed to the WWTS and the FTB is required at internal monitoring points located at the FTB Seepage Containment System (WS002) and the FTB South Seepage Management System (WS003). Monitoring at these locations is required to determine water quality of the collected seepage prior to it being treated by the WWTS and/or routing to the FTB. Monthly monitoring of both of these monitoring points is required for Group B parameters and twice per year for Group C parameters.

Hydrometallurgical Residue Facility (HRF)
The Hydrometallurgical Residue Facility is a closed-loop system with no discharge to ground or surface waters. Water is recirculated through the facility and reused in the hydrometallurgical process. The permit requires monthly monitoring of the HRF Pond water at WS004 and any leachate collected by the HRF Leakage Collection System at WS005 for Group B parameters and annual monitoring for Group C parameters.

Sewage Treatment Stabilization Ponds
The domestic sewage treatment stabilization ponds discharge to the FTB. An internal monitoring point is required to monitor the discharge at Station WS009 from the domestic sewage treatment stabilization ponds. Sampling is required twice per week during discharge to the FTB for $CBOD_5$, TSS, pH, and fecal coliform; these are parameters indicative of domestic wastewater. Because of the very large amount of dilution provided by the intervening storage of the stabilization pond effluent within the FTB, the resulting infiltration and subsurface travel of the FTB pond contents through the tailings to the FTB Seepage Capture System, and the degree of treatment provided by the WWTS, no sewage secondary treatment effluent limits (e.g., CBOD, fecal organisms) are included for outfall SD001. Given these circumstances, it is highly probable that WWTS effluent concentrations of these parameters would be exceedingly small and it is unlikely that specific monitoring of the WWTS effluent would be capable of detecting them. The average flow rate of sewage from the stabilization ponds of approximately 24 gpm is inconsequential when compared against the design capacity of the WWTS at 3600 gpm.

Plant Site – Groundwater Monitoring
Monitoring of the groundwater will be required at 40 locations at the Plant Site. The groundwater monitoring well network at the Plant Site has been designed to gather sufficient groundwater quality and groundwater elevation data to assess the performance of the Project engineered controls and the Project's potential for impact to groundwater resources during both operation and reclamation/closure. The groundwater data will also be used to help assure that there will be no impact to surface waters of the State. The Plant Site groundwater monitoring well network includes 17 surficial aquifer monitoring wells, 9 bedrock monitoring wells, and 14 piezometers (for water level measurements), which can be categorized into the following groups:

- FTB Seepage Containment System Wells & Piezometers (Performance Wells)
- Surficial Aquifer Wells
- Bedrock Aquifer Wells

FTB Seepage Containment System Wells & Piezometers
The performance of the FTB Seepage Containment System surrounding the FTB will be monitored using paired monitoring devices located along the containment system at the toe of the FTB dam. Each monitoring pair will include one device located on the inward side of the containment system and one on the outward side. The monitoring system will include alternating pairs of monitoring wells (for water quality and water level measurements) and piezometers (for water level measurements only). Monthly monitoring of water levels in the 14 piezometers (7 pairs) is required in the permit to ensure the FTB Seepage Containment System is maintaining an inward gradient and is preventing the flow of potential pollutants to the surficial aquifer. Twelve monitoring wells (6 pairs) will be installed in the surficial aquifer along the FTB Seepage Containment System and are required to be monitored quarterly for Group A parameters, which will serve as an early indicator of any potential release of contaminants from the seepage containment system moving to the surrounding groundwater.

Surficial Aquifer Wells:

In addition to the engineered systems performance monitoring at the FTB Seepage Containment System, groundwater quality downgradient of the Plant Site between the FTB and the Embarrass River will be monitored at three surficial aquifer monitoring wells near the property boundary. Water quality will be monitored quarterly for Group B parameters and annually for Group C parameters. Data from the wells at the property boundary will be used to help assess compliance with applicable groundwater standards.

Two background monitoring wells have been installed in the surficial aquifer to monitor baseline conditions near the Tailings Basin. Monitoring well GW002 will monitor baseline conditions west and upgradient of the FTB and HRF. Monitoring well GW015 is located to the west and downgradient of Cell 2W, and monitoring has shown it to be unimpacted by existing tailings basin seepage. Baseline conditions will be monitored quarterly for Group B parameters and annually for Group C parameters.

Bedrock Wells:
Nine bedrock monitoring wells will be installed at the Plant Site. The bedrock monitoring wells will monitor groundwater downgradient of the Cell 2W, Cell 2E, and the FTB and are located along similar groundwater flow paths as the surficial aquifer wells. The bedrock aquifer monitoring wells will be monitored quarterly for Group B parameters and annually for Group C parameters.

As at the Mine Site, the parameters and frequency of monitoring for each category of monitoring device at the Plant Site depend on the location and specific purpose of the monitoring. This monitoring also utilizes a tiered approach with more frequent monitoring of key indicator parameters in conjunction with less frequent monitoring of a wider range of parameters. As above, key indicator parameters with quarterly monitoring include, at most locations, arsenic, bicarbonate, calcium, chloride, cobalt, copper, hardness, iron, magnesium, manganese, nickel, pH, specific conductance, sulfate, total dissolved solids, and water levels. The wider list of parameters to be monitored annually at most locations include relevant metals and inorganic constituents. The quarterly and annual monitoring frequencies for water quality sampling are sufficiently frequent due to the very slow flow velocities of groundwater at the site (on the order of a few feet to tens of feet per year). Monthly monitoring of water levels at the FTB Seepage Containment System is being required to provide timely assessment of system performance. The Plant Site groundwater monitoring network is summarized in Table 12.

Table 12 - Plant Site Groundwater Monitoring Summary

Type	Number of Locations	Frequency	Parameter List	Notes	Station Numbers
FTB Seepage Containment System (Water Levels)	14	Monthly	Water Level only	6 sets of paired piezometers	GW202 – GW223*
FTB Seepage Containment System (Water Quality)	12	Quarterly	Group A(1)	6 sets of paired monitoring wells	GW200 – GW221*
Surficial Aquifer Wells (Water Quality)	5	Quarterly Annually	Group B(2) Group C(3)	Background and Property Boundary	GW002, GW009, GW010, GW015, GW016, GW236 – GW237
Bedrock Monitoring Wells (Water Quality)	9	Quarterly Annually	Group B(2) Group C(3)	Toe, Property Boundary, Background	GW109 – GW121*

*Gap in monitoring station sequence

(1) Group A Monitoring key indicator parameters include. Chloride, specific conductance, sulfate, total dissolved solids and water levels.
(2) Group B Monitoring parameters of interest include: Arsenic, bicarbonate, calcium, chloride, copper, hardness, magnesium, manganese, nickel, pH, specific conductance, sulfate, total dissolved solids, and water levels.
(3) Group C Monitoring parameters of interest include: Aluminum, antimony, boron, beryllium, barium, cadmium, chromium, cobalt, fluoride, lead, selenium, thallium, and zinc.

Plant Site – Surface Water Monitoring

Monitoring of nearby surface waters at six locations will be required at the Plant Site. The Plant Site surface water monitoring stations are categorized into two groups:

- Background surface water monitoring
- Downstream surface water monitoring

Background Surface Water Monitoring

One background monitoring station at PM-12.2 in the Embarrass River will be located upstream of the Tailings Basin and Plant Site and downstream of Cliffs Erie Mining Area 5. Monitoring of the upstream background monitoring station will be used to establish background/baseline conditions at the Plant Site against which downstream monitoring can be compared. Monitoring of the background station will be required monthly for Group B parameters and twice per year for Group C parameters.

Downstream Surface Water Monitoring

A total of five surface water monitoring stations will be located downstream of the Plant Site:

- Unnamed Creek – headwaters station downgradient from the Tailings Basin at PM-11
- Embarrass River – downstream of all Plant Site contributions at PM-13
- Trimble Creek – headwaters station downgradient of the Tailings Basin at TC-1a
- Unnamed (Mud Lake) Creek – headwaters station downgradient of the Tailings Basin at MLC-1
- Second Creek – headwaters station downgradient of the Tailings Basin at PM-7

Monitoring of the downstream monitoring stations will be used to establish baseline conditions at the Plant Site prior to mining operations and to monitor potential project impacts once mining operations begin. Monitoring of the downstream monitoring stations will be required monthly for Group B parameters and twice per year for Group C parameters.

Additional Monitoring

Chronic Whole Effluent Toxicity Testing
As described in the Reasonable Potential section above, the MPCA has conducted a Reasonable Potential analysis and has determined there is no reasonable potential for NorthMet's proposed discharges to cause or contribute to a violation of water quality standards in the receiving waters.

The Project is considered a "major" facility by EPA. All major facilities are required to conduct either chronic or acute toxicity testing on the effluent from their wastewater treatment systems. Monitoring for whole effluent toxicity looks at the entire mixture of wastewater to determine whether the effluent is toxic. The permit requires PolyMet to monitor for Chronic Whole Effluent Toxicity (WET) for the life of the permit. The MPCA policy is to require Chronic WET testing when the receiving water to effluent ratio is less than or equal to 20:1. The permit contains chronic WET testing because the ratio of the receiving water $7Q_{10}$ flow to the facility's proposed monthly average flow is zero.

The MPCA conducted a reasonable potential analysis on various parameters while reviewing the permit application and determined there is no reasonable potential to cause or contribute to an exceedance of water quality standards, including the narrative standard against toxicity in the discharge. However, to address concerns raised during the public notice period, the MPCA is proposing to include a chronic toxicity limit of 1.0 TUc applicable at Station SD001. The permit requires quarterly toxicity testing for the entire permit term. The quarterly monitoring frequency was chosen due to the potential for variability in the effluent during the WWTS startup period and the expectation that the influent concentrations of wastewater to the WWTS could increase over time as mining progresses. The chronic toxicity tests must be conducted in accordance with procedures outlined in EPA 821 R 02 013 "Short-term Methods for Measuring the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms". Fourth Edition (Chronic Manual) and any revisions to the Manual.

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Nutrients

Nitrogen
Nitrogen is a pollutant that can negatively impact the quality of Minnesota's water resources, including water used for drinking. Studies have shown that excess nitrogen in lakes and streams has a toxic effect on aquatic life such as fish. Like phosphorus, nitrogen is a nutrient that promotes algae and aquatic plant growth often resulting in decreased water clarity and oxygen levels. In September 2014, the MPCA completed the final draft of the Statewide Nutrient Reduction Strategy (http://www.pca.state.mn.us/zihy1146) which identifies goals and milestones for nitrogen reductions for both point and nonpoint nitrogen sources within Minnesota. To gain a better understanding of the current nitrogen concentrations and loadings received by and discharged from the facility, effluent nitrogen monitoring has been added to the Permit.

The permit includes effluent monitoring for Nitrite plus Nitrate-Nitrogen, Total Kjeldahl Nitrogen and Total Nitrogen at a frequency of twice per year for the five-year term of the permit. There is no nitrogen limit in the permit.

This additional monitoring will provide the data necessary to develop a better understanding of the total nitrogen concentrations and loadings that is currently being received and discharged from municipal and industrial wastewater treatment plants. Once a more extensive total nitrogen data set is established nitrogen reduction work can begin to achieve the necessary reductions to meet the goal of a 20% reduction in total nitrogen loads from point source dischargers by 2025. The changes and/or increases in total nitrogen monitoring in wastewater permits as a result of the Statewide Nutrient Reduction Strategy is outlined in the Minnesota NPDES Wastewater Permit Nitrogen Monitoring Implementation Plan document located on the MPCA wastewater permits webpage at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/wastewater/wastewater-permits/index.html.

Phosphorus
Phosphorus is a common constituent in many wastewater discharges and a pollutant that has the potential to negatively impact the quality of Minnesota's lakes, wetlands, rivers, and streams. Phosphorus promotes algae and aquatic plant growth often resulting in decreased water clarity and oxygen levels. In addition to creating general aesthetic problems, these conditions can also impact a water body's ability to support healthy fish and other aquatic species. Therefore, phosphorus discharges are being carefully evaluated throughout the state. Phosphorus is required to be monitored in the discharge twice per year in the permit to verify the expected low concentrations of nutrients in the discharge.

Special Permit Requirements

40 CFR 440 – Allowable Discharge

Effluent Guidelines are national regulatory standards for wastewater discharged to surface waters and municipal sewage treatment plants. EPA issues these regulations for industrial categories, based on the performance of treatment and control technologies. In addition to the numerical technology based effluent limits identified in the Technology Based Effluent Limitations section above, 40 CFR § 440.104(b)(1) states, in part, "there shall be no discharge of process wastewater to navigable waters from mills that use the froth-flotation process alone, or in conjunction with other processes, for the beneficiation of copper, lead, zinc, gold, silver, or molybdenum ores or any combination of these ores." *Process wastewater* is defined in 40 CFR § 122.2 as any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product. The Project will produce process wastewater that is subject to this requirement.

The federal effluent limit guidelines at 40 CFR part 440 identify two kinds of water that are not subject to the limitation on discharge of process wastewater: combined waste streams and net precipitation.

40 CFR § 440.131(a) discusses combined waste streams and states:

> In the event that waste streams from various subparts or segments of subparts in part 440 are combined for treatment and discharge, the quantity and concentration of each pollutant or pollutant property in the combined discharge that is subject to effluent limitations shall not exceed the quantity and concentration of each pollutant or pollutant property that could have been discharged had each waste stream been treated separately. In addition, the discharge flow from the combined discharge shall not exceed the volume that could have been discharged had each waste stream been treated separately.

Mine drainage is the only waste stream combined with process wastewater that the Permittee proposes to count toward the "allowable discharge" that would not be prohibited by 40 CFR § 440(b)(1). Mine drainage, defined in 40 CFR § 440.132(h) as "any water drained, pumped, or siphoned from a mine" is excluded from the definition of "process wastewater" as used in this part.

At the Project, mine drainage will be combined with process wastewater in the FTB Pond. Mine drainage will include all water pumped from the Mine Site to the Plant Site (includes water pumped directly to the FTB Pond and water pumped to the WWTS for treatment). No mine drainage will be directly discharged to the receiving waters, rather the discharge will consist of treated water from the WWTS.

The permit proposes the following formula to determine the "allowable discharge" that would not be prohibited by 40 CFR § 440(b)(1):

Da = Y + Dm

Where:

Da = Allowable discharge
Y = Annual net precipitation

Dm = Mine drainage

In addition, 40 CFR § 440.104(b)(2)(i) states:

> In the event that annual precipitation falling on the treatment facility and the drainage area contributing surface runoff to the treatment facility exceeds the annual evaporation, a volume of water equal to the difference between annual precipitation falling on the treatment facility and the drainage area contributing surface runoff to the treatment facility and annual evaporation may be discharged subject to the limits set forth in [§440.104(a) (Table 2)] of this section.

The permit proposes the following formula to allow for this provision in the event precipitation exceeds annual evaporation at the site:

Y = (Af x P) - (At x E)

where:

Y = annual net precipitation
Af = area of Tailings Basin (FTB + Cell 2W) plus the drainage area contributing surface runoff to the Tailings Basin and to the FTB seepage capture systems
P = total annual precipitation
At = open water area of the Tailings Basin
E = annual reservoir evaporation

The total allowable annual discharge under the permit is limited to the volume of net precipitation calculated using the above formula, plus the volume of mine drainage discussed above.

Under the permit, if the Permittee does not discharge the allowable annual discharge volume in a given calendar year, then the Permittee may carry over the difference between the allowable annual discharge volume and the actual volume discharged as a credit to the allowable annual discharge volume for the following calendar year. Such credit may be carried over only to that calendar year immediately following the year in which not all of the allowable annual discharge volume was utilized. This provision recognizes and takes into account the fact that it is probable that precipitation falling in one year may not actually be discharged until the following year; travel and/or residence time within the wastewater management system may exceed one year. Modeling conducted for the EIS indicates that it could take a minimum of 2 and 7 years for FTB pond water to move vertically and horizontally through the tailings (depending on where in the pond the water infiltrates, the thickness of the tailings, and the linear distance of flow through the tailings) before it would be captured by the seepage collection system, treated and discharged. It is reasonable to acknowledge this reality when applying the regulation. The approach is consistent with the intent of the regulation because the volume discharged will always remain below the cumulative net precipitation plus mine drainage. This is also consistent with MPCA's past implementation of this requirement at other mining facilities.

MPCA also considered an alternative approach for calculating an allowable discharge similar to that utilized by EPA and the State of Alaska in the permitting of the Red Dog copper mine in Alaska. The Fact Sheet for that permit explains an annual discharge limit (in billions of gallons per year) based on "the *maximum* estimated difference between precipitation and evaporation" (emphasis added). Because the approach for calculating an allowable discharge for this permit uses the *actual* precipitation in a given year coupled with the *average* evaporation rate, the allowed discharge volume is considerably less than it would be if a maximum difference between precipitation and evaporation were used in the calculation. This remains the case even when a "carryover" from the previous year is included. In other words, the approach utilized by MPCA for this permit results in a smaller allowable discharge than would be allowed under a Red Dog Mine approach, both on an annual basis and cumulatively over the life of the permit, and is thus more protective. Calculations derived from information submitted by PolyMet using the 95th percentile of precipitation over the area draining to the tailings basin (35.2in/yr) against the 50th percentile of evaporation from the entire tailings basin area (open water plus beaches) (17.1"/yr) indicates a maximum allowable discharge of approximately 4.06 billion gallons per year, using the Red Dog approach. This value would reasonably approximate the *maximum* difference between precipitation and evaporation and is more than double the maximum discharge rate predicted by GoldSim modeling conducted for the NPDES/SDS permit application. Based on the above information, MPCA concluded that the approach proposed in the permit is more protective than the alternative approach used elsewhere by the EPA and the State of Alaska. To provide an explicit limit immediately available during operations, the MPCA is also including a condition limiting the annual discharge to 4060 million gallons per year, based on the Red Dog approach.

The Permittee is required to report the net annual precipitation volume and the annual mine drainage volume compared to the volume of water discharged through Outfalls SD002 – SD011 in the Comprehensive Annual Performance Evaluation Report.

No Unauthorized Discharge to Surface Waters

Mine Site

The only allowable discharges from the Mine Site are those authorized by Minnesota's Industrial Stormwater General Permit and Construction Stormwater General Permit. The permit explicitly prohibits the discharge of any mine water or other process wastewater directly from the Mine Site to any surface waters. As used in the permit, "direct discharge" refers to a discharge from the source (e.g., the Mine Site) to any surface water without going through the WWTS and an authorized outfall. The permit prohibits such discharges. The permit also contains conditions designed to prevent the indirect pollution of surface water via groundwater through monitoring, evaluation, and, if necessary, adaptive management. The only discharges to surface water authorized by the permit are those at the outfalls SD002-SD011. All mine water or other process wastewater (which includes mine pit dewatering, wastewater from the Category 1 Waste Rock Stockpile Groundwater Containment System, leachate and runoff from stockpiles and storage areas, and runoff from haul road surfaces) will be collected in various sumps and collection systems at the Mine Site, routed to the Equalization Basins also at the Mine Site, and then pumped via pipeline to the Plant Site for storage in the FTB or treatment at the WWTS and discharge through station SD001 to outfalls SD002 – SD011.

Each of the Mine Site features will be constructed and managed such that there is no point source discharge to surface waters nor a discernable impact to surface waters or groundwater. The permit includes provisions that are intended to provide assurance that the engineering controls are constructed and operated to maximize performance and minimize the potential for an unauthorized discharge. The permit requires that the Permittee construct the waste rock stockpile liner and/or groundwater containment systems consistent with what was proposed in the permit application with respect to general design, particularly as it relates to performance of proposed barrier and liner systems. This requirement is included for the Category 1 Waste Rock Stockpile Groundwater Containment System, the Category 2/3 stockpile, Category 4 stockpile and Ore Surge Pile liner systems and for the low concentration and high concentration Equalization Basins.

The permit stipulates that any proposed change in the design of these features from that described in the permit, or any time thereafter, must be submitted to MPCA for review and approval. This would include an assessment as to whether the change would require a major modification of the permit pursuant to Minn. R. 7001.0170, including a public notice of the proposed modifications.

Additionally, the permit requires the Permittee to provide: (1) a signed certification by a professional engineer registered in the state of Minnesota asserting that the project, as constructed, meets the required design performance standards, (2) a certification of completion of an operation and maintenance manual that includes a discussion of operational controls, sampling and analysis and problem mitigation, and (3) the submittal of as-built plans and specifications and QA/QC test results. At the Mine Site, these provisions are applicable to the Category 1 Waste Rock Stockpile Groundwater Containment System and the Category 2/3 stockpile, Category 4 stockpile and Ore Surge Pile liner systems. In addition to the stockpiles, the permit includes requirements specific to the design, construction and operation of the low concentration and high concentration Equalization Basins located at the Mine Site.

The permit requires monitoring of the performance of the Mine Site engineering controls and the groundwater quality downgradient of the Mine Site features. This monitoring will ensure protection of groundwater in accordance with the requirements of Minnesota Rules chapter 7060 as well as ensure there is no impact to surface waters from the Mine Site. Mine Site features with the potential to affect groundwater are the Category 1, 2/3 and 4 Stockpiles, Ore Surge Pile , Overburden Storage & Laydown Area, and the Wastewater Equalization Ponds (Table 13). These features and their associated engineering controls to minimize affects to groundwater are further described below.

Table 13 - Overview of Mine Site Infrastructure with Potential Nonpoint Discharge to Groundwater (SDS)

Project Feature	Source of Potential Groundwater Flow	FEIS/Permit Application Assumed Flow Rate to Groundwater (gpm)
Category 2/3 Waste Rock Stockpile (Temporary)	Liner Leakage	0.019(1)
Ore Surge Pile (Temporary)	Liner Leakage	0.0012(1)
Wastewater Treatment Equalization Basins	Liner Leakage	0.014(1)
Overburden Storage and Laydown Area	Infiltration	14(1)
Category 1 Waste Rock Stockpile	Flow bypassing Category 1 Stockpile Groundwater Containment System	6.8(2)

(1) Information from Table 5.2.2-27 of the FEIS
(2) Mine Year 11 (maximum) flow to bedrock that bypasses the containment system and does not discharge to the West Pit. Information from Section 5.2.2 (p.5-145) of the FEIS

The monitoring required in the permit will identify the potential for impacts to surface water far enough in advance to allow implementation of adaptive management or mitigation actions that would prevent the impacts from occurring.

Permanent Category 1 Waste Rock Stockpile

Potential groundwater impacts from the Category 1 Waste Rock Stockpile (the only permanent waste rock stockpile at the Mine Site) will be controlled by installation of a groundwater containment system near the toe of the stockpile consisting of a low-permeability compacted soil hydraulic barrier (cutoff wall) coupled with a drainage collection system.

Drainage collected by the groundwater containment system will be routed to a number of lined sumps adjacent to the toe of the stockpile and from there pumped via piping to the lined wastewater equalization basins at the Mine Site. From there, the stockpile drainage, in combination with other Mine Site wastewater flows, will be pumped to the Plant Site for treatment at the WWTS. The containment system as designed will lower the water table on the inward side of the cutoff wall relative to the level that is maintained on the outward side. This will establish an inward hydraulic gradient thereby eliminating the potential for stockpile drainage to enter the surficial groundwater system. Any leakage through the low-permeability cutoff wall will be inward and will end up as part of the wastewater collected for treatment.

Engineering controls:

- Installation of a groundwater containment system consisting of a cutoff wall (low-permeability compacted soil hydraulic barrier) combined with a drainage collection system around the perimeter of the stockpile near the stockpile toe. The groundwater containment system will be part of the initial construction prior to the stockpiling of waste rock and will be incrementally expanded as the stockpile is developed.
- Installation of a geomembrane cover system during the life of the Project to reduce pollutant load by reducing infiltration of precipitation. The cover system will be constructed incrementally as the stockpile is constructed during the period of mine operation and once completed will be maintained during closure and post closure.
- Mine pit dewatering will draw and collect groundwater and pump it to the WWTS for treatment. (The containment system and mine pits are expected to capture virtually the entire amount of stockpile drainage generated.)

Monitoring of the performance of the groundwater containment system will be conducted by the following:

- 7 sets of paired piezometers (14 total) along the length of the groundwater containment system, with one piezometer of each pair on the inward side of the cutoff wall and one on the outward side. The water level (i.e., groundwater elevation) will be monitored monthly at each piezometers to ensure that an inward-directed hydraulic gradient is maintained.
- 6 sets of paired monitoring wells (12 total) along the length of the groundwater containment system, with one well of each pair on the inward side of the cutoff wall and one on the outward side. The water level at each well will be monitored monthly to ensure that an inward-directed hydraulic gradient is maintained, with water quality for indicator pollutants being monitored quarterly.
- 3 monitoring wells in the surficial aquifer downgradient of the Category 1 stockpile will be monitored quarterly for water quality.

Temporary Waste Rock (Category 2/3 and Category 4) Stockpiles & Ore Surge Pile

Category 2/3 waste rock, Category 4 waste rock and ore material that is stored temporarily at the Ore Surge Pile prior to transport to the processing plant at the Plant Site will be placed in separate temporary stockpiles at the Mine Site. Each of these stockpiles will have engineered geomembrane-based liner systems that will collect any water that has contacted the rock.

The engineered liner system will consist of an overliner drainage layer, an impermeable composite liner barrier, and, if necessary, a foundation underdrain system located below the impermeable composite barrier. The impermeable composite liner barrier, comprised of a compacted soil liner overlain by a geomembrane layer will prevent stockpile drainage from infiltrating downward. The overliner drainage layer will minimize the development of hydraulic head on the impermeable liner, which will minimize the potential for groundwater impacts due to any liner defects. The liners' integrity will be protected by the foundation underdrain systems in areas where high groundwater is encountered to minimize potential for excess pore pressures adversely affecting the performance of the liner system as the stockpile is loaded. These three liner design components (underdrains, impermeable barrier, and overliner drainage layer) function as a system to enhance overall liner integrity and stockpile stability.

Stockpile drainage will be collected above the liner in the high permeability overliner drainage layer, routed to lined sumps located at the toe of the stockpile, and then pumped to the Mine Site equalization ponds prior to pumping to the WWTS at the Plant Site for treatment.

The temporary nature of these stockpiles will also limit their potential impacts to groundwater. The Category 2/3 Waste Rock Stockpile, the Category 4 Waste Rock Stockpile, and the Ore Surge Pile will have expected operating lives of 11 to 21 years. At the end of their operating lives, PolyMet will remove these temporary waste rock stockpiles and reclaim their footprints. Because these stockpiles are temporary, rather than permanent, there is less potential for degradation of the liners over time, and limited duration of potential groundwater effects from these features.

Groundwater surrounding the temporary stockpiles will be monitored using five monitoring wells screened in the surficial aquifer. These wells (GW491-GW495) will be monitored quarterly for a focused set of key parameters and annually for a wider set of parameters.

Overburden Storage & Laydown Area (OSLA)
PolyMet will use the OSLA to screen, sort, and temporarily store peat and unsaturated overburden for future use at the Mine Site. Potential groundwater impacts from the OSLA will be controlled by facilitating the collection of runoff and drainage from the site to limit infiltration. Although the OSLA will not have an engineered liner system, the OSLA will be graded and compacted to enhance drainage. Drainage will be collected in an unlined mine water pond, then pumped to the FTB at the Plant Site. The OSLA runoff is expected to be of sufficient water quality so as not to require treatment beyond settling to remove suspended solids prior to pumping to the FTB. Any mercury that may be released from the stored peat will be removed with the settled solids in the collection pond and/or via filtration and adsorption by tailings particles at the FTB.

Groundwater downgradient of the OSLA will be monitored using one monitoring well screened in the surficial aquifer. This well (GW411) will be monitored quarterly for a focused set of key parameters and annually for a wider set of parameters.

Low Concentration and High Concentration Equalization Basins
Potential groundwater impacts from the equalization basins at the Mine Site will be controlled by installation of a composite liner system consisting of a geosynthetic clay and 60 mil geomembrane over a one-foot thick soil liner. Model calculations based on typical liner characteristics, expected hydraulic head, and measured hydraulic conductivity of system components indicate that leakage from the basins will be minimal and will not adversely affect Mine Site groundwater.

The permit includes provisions for the Equalization Basins related to locational standards, operating depth/freeboard, inspection, maintenance, and solids removal. These provisions are consistent with those required statewide for industrial wastewater storage ponds. The permit also requires submittal, prior to permit reissuance, of an Equalization Basin Performance Evaluation Report certified by a licensed professional engineer with expertise in wastewater structures that the basins continue to meet the technical criteria of its original design.

The permit explicitly prohibits a direct discharge from the Mine Site Equalization Basins or any other industrial mine water pond system to surface waters. The permit directs that the Equalization Basins may only discharge to the FTB or the WWTS.

To minimize the potential of an unauthorized discharge from the Equalization Basins, the permit requires that an inventory of essential spare or replacement components be maintained on site or be available from a confirmed local/regional vendor within 48 hours. Essential components in this context include, at a minimum, redundant pumping capacity, spare piping and other replacement parts needed to restore operation in the shortest time possible and to prevent an unauthorized discharge

Mine Pits

Groundwater and surface runoff entering the three mine pits (East Pit, Central Pit and West Pit) will be collected in sumps in the pits and routed to the WWTS at the Plant Site for treatment. During operations when the mine pits are being dewatered, groundwater flow will be inward to the pits. As a result there will be no outward flow of groundwater from the mine pits to the surficial or bedrock aquifers; thus there will be no impact to downgradient groundwater quality.

Groundwater downgradient of the mine pits will be monitored using the same monitoring well network in place for the stockpiles. These wells will be monitored quarterly for a focused set of key parameters and annually for a wider set of parameters.

Mine Water Sumps & Overflow Ponds

Potential groundwater impacts from the temporary stockpile drainage sumps will be controlled by the installation of double liners and leak collection and recovery systems. The leak collection and recovery systems will return any leakage through the upper layer of the liner system to the sump. Other mine water ponds will be constructed with liner systems based on the quality of the collected water: a double liner (RTH drainage), a single liner (haul road drainage), or no liner (OSLA drainage). Overflow ponds, which will only receive stockpile runoff during precipitation events larger than the 10-year, 24-hour event and will completely contain runoff up to the 100-year, 24-hour event as evaluated in the FEIS, will be constructed with a single-liner system overlying a one-foot-thick soil liner. Model calculations based on typical liner characteristics, expected hydraulic head, and measured hydraulic conductivity of system components show that leakage from the sumps and ponds will be controlled to the maximum practicable extent.

As discussed above, the groundwater downgradient of the stockpiles, mine pits and other Mine Site features will be monitored quarterly for a focused set of parameters and annually for a wider set.

Plant Site

Discharges from the Plant Site to surface waters include those authorized by this permit through the WWTS at SD001 and Outfalls SD002 – SD011 and those authorized by the Industrial Stormwater General Permit and the Construction Stormwater General Permit. The permit explicitly prohibits any direct discharge of wastewater to surface waters from the FTB pond, the FTP Seepage Containment System and the South Seepage Management System. Prior to discharge through Outfall SD001, water from these sources must first be routed for treatment through the Tailings Basin Seepage Treatment Train of the WWTS. Direct discharge to surface waters from the Mine Water Chemical Precipitation or Mine Water Filtration Trains of the WWTS is not authorized by the permit.

Each of the Plant Site features with the potential to affect groundwater will be constructed and managed such that there is no point source discharge to surface waters nor a discernable impact to surface waters or groundwater. As with the Mine Site, the permit includes provisions for the Plant Site that are intended to provide assurance that the engineering controls are constructed and operated to maximize performance and minimize the potential for an unauthorized discharge. The permit requires that the Permittee construct the FTB Seepage Containment System and the South Seepage Management System consistent with what was proposed in the permit application with respect to general design, particularly as it relates to performance of proposed barrier systems and the fundamental components of the WWTS (e.g., the inclusion of membrane treatment technologies). The permit stipulates that any proposed change in the design of the FTB Seepage Containment System prior to construction from that described in the permit, or any time thereafter, must be submitted to MPCA for review and approval. This would include an assessment as to whether the change would require a major modification of the permit pursuant to Minn. R. 7001.0170, including a public notice of the proposed modifications. The permit also explicitly applies this provision to the WWTS.

Additionally, the permit requires the Permittee to provide: (1) a signed certification by a professional engineer registered in the state of Minnesota asserting that the project, as constructed, meets the required design performance standards, (2) a certification of completion of an operation and maintenance manual that includes a discussion of operational controls, sampling and analysis and problem mitigation, and (3) the submittal of as-built plans and specifications and QA/QC test results. At the Plant Site, these provisions are applicable to the FTB Seepage Capture System, the South Seepage Management System and the WWTS.

To avoid or minimize downtime in the operation of the FTB Seepage Containment System and the South Seepage Management System in the event of a system malfunction and to avoid an unauthorized discharge, the permit requires that an inventory of essential spare or replacement components for the systems be maintained on site or be available from a confirmed local/regional vendor within 48 hours. Essential components in this context include, at a minimum, redundant pumping capacity, spare piping and other replacement parts needed to restore operation in the shortest time possible and to prevent an unauthorized discharge.

The permit requires monitoring of the performance of the Plant Site engineering controls and the groundwater quality downgradient of the Plant Site features. This monitoring will protect groundwater in accordance with the requirements of Minnesota Rules chapter 7060 and ensure there is no unauthorized discharge to surface waters from the Plant Site. Plant Site features with the potential to affect groundwater are the Flotation Tailings Basin and the Hydrometallurgical Residue Facility (Table 14). These features and their associated engineering controls to minimize affects to groundwater are further described below.

Table 14 - Overview of Plant Site Infrastructure with Potential Nonpoint Discharge to Groundwater (SDS)

Project Feature	Source of Potential Groundwater Flow	FEIS/Permit Application Assumed Flow Rate to Groundwater (gpm)
Tailings Basin	Flow bypassing FTB seepage capture system	20(1)
Hydrometallurgical Residue Facility (HRF)	Flow bypassing HRF Leakage Collection System	0(2)

(1) Information from Table 5.3.3-37 of the FEIS
(2) Any minimal leachate bypassing the HRF Seepage Capture System would be captured by the FTB Seepage Capture System prior to release to the environment

Plant Site – FTB Seepage Capture Systems

The FTB Seepage Containment System and the FTB South Seepage Management System (collectively known as the FTB seepage capture systems) will collect water seeping from the Tailings Basin as surface seepage or seepage to groundwater. The FTB Seepage Containment System will surround the western and northern sides and extend to a portion of the eastern side of the Tailings Basin. It will consist of a cutoff wall installed to the top of the bedrock, with a collection trench and drain pipe installed on the upgradient side (Tailings Basin side) of the cutoff wall. The collected seepage will then be pumped to the WWTS for treatment prior to discharge.

The FTB South Seepage Management System, which will be an enhancement of the existing SD026 pumpback system, consists of a berm, trench, and pumpback system and collects seepage on the southern side of the FTB. The seepage collected by this system will also be pumped to the WWTS for treatment and discharge or to the FTB Pond for reuse.

PolyMet will construct the FTB seepage capture systems to capture tailings basin seepage including both surface seepage emanating to the surface from the toe of the basin and seepage entering the surficial aquifer through the bottom of the basin. The systems will capture both nonferrous seepage from the Project Tailings Basin as well as existing legacy ferrous seepage from the basin. Over time, these engineering controls are expected to attenuate existing groundwater impacts outside of the FTB seepage capture systems that are attributable to the former taconite operations.

Monitoring of the performance of the FTB Seepage Containment System will be conducted by the following:

- 6 sets of paired piezometers (12 total) along the length of the FTB Seepage Containment System, with one piezometer of each pair on the inward side of the cutoff wall and one on the outward side. The water level (i.e., groundwater elevation) will be monitored monthly at each piezometers to ensure an inward-directed hydraulic gradient is maintained.
- 6 sets of paired monitoring wells (12 total) along the length of the FTB Seepage Containment System , with one well of each pair on the inward side of the cutoff wall and one on the outward side. The water level at each well will be monitored monthly to ensure that an inward-directed hydraulic gradient is maintained, with water quality for indicator pollutants being monitored quarterly.
- 3 monitoring wells in the surficial aquifer downgradient of the FTB will be monitored quarterly for water quality.

Hydrometallurgical Residue Facility (HRF)
The HRF is designed as a closed system; during operation no water from the HRF will be discharged to surface waters either via leakage/overflow or as a treated discharge. Based on the design of the liner system for the HRF (discussed below), no seepage from the HRF to groundwater is expected. Any water lost from this closed loop system will be due to evaporation from the cell surface and entrainment within the pore spaces of the deposited residue.

The HRF will have a double liner with leakage collection, as described below.

- Upper Liner – The upper geomembrane liner serves as the primary barrier to leakage from the HRF. The selection of the geomembrane (type and thickness) will consider performance needs with respect to the physical and chemical characteristics of the residue, constructability issues and long-term durability (including UV exposure and the ability to resist ice impacts in the event of any temporary shutdowns of the hydrometallurgical process in winter months). The upper liner will be subject to hydraulic head equal to the water level in the HRF. Leakage through any unintended defects in the upper liner will be driven by the defect size and frequency, and by the hydraulic head at the location of the defect.

- Leakage Collection Layer – The leakage collection layer will gather any water that passes through the upper liner to minimize the hydraulic head on the lower liner. Collected leakage will be directed to a sump then pumped back to the HRF pond. Together, the leakage collection layer and the associated sump, pumps, and piping comprise the Leakage Collection System.

- Lower Liner – The lower composite liner provides a virtually leak-free barrier to prevent any leakage passing through the upper liner from leaving the HRF. This virtually leak-free performance is achieved because the hydraulic head on the lower liner will be so low that there will not be enough force to drive leakage through any defects in the lower liner system. Any leakage through the upper liner will be retained above the lower liner and collected by the Leakage Collection System.

Calculations based on typical defect size and frequency, expected hydraulic head, and measured hydraulic conductivity of system components show that no leakage is expected through the lower composite liner.

The HRF will also have a Drainage Collection System, which will be installed during initial HRF construction but would not be activated until after mining operations cease. At that point, the accumulated residue in the HRF will be dewatered to facilitate final closure. Drainage in this context is the water that flows through the residue and is collected above the upper layer of the liner system. The Drainage Collection System will be used during site closure to expedite residue dewatering

Special Permit Requirements – No Unauthorized Discharge

- Permit conditions specifically prohibiting direct discharge of any mine water or other process wastewater to surface waters from the Mine Site.
- Permit condition prohibiting direct discharge from the FTB Seepage Containment System, the South Seepage Management System, and the HRF Leachate Collection Systems at the Plant Site.
- Requirement for all water collected by the groundwater containment systems at the Category 1 Waste Rock Stockpile and the FTB seepage capture systems to be routed to the WWTS or pumped to the FTB.
- Requirement to monitor and maintain a series of paired piezometers and wells at the Category 1 Waste Rock Stockpile and the FTB Seepage Containment System.
- Requirement for the facility to maintain an inward gradient at Category 1 Waste Rock Stockpile and the FTB Seepage Containment System and required actions in the event inward gradients are not maintained.
- Requirement to conduct regularly scheduled inspections of the FTB Seepage Containment System and HRF Leachate Collection System

As outlined above, the permit requires an inward hydraulic gradient be maintained across the FTB Seepage Containment System and the Category 1 Waste Rock Groundwater Containment System as determined by water level measurements from the paired piezometers and monitoring wells located on either side of the containment system barriers. In the event that water level measurements indicate an inward gradient is not being maintained, the permit identifies a list of mitigation actions that must be implemented as needed to restore the inward gradient. These include immediate actions such as removing ponded water from the interior side of the barrier, repairing or replacing malfunctioning pumps or pipes, and increasing the monitoring frequency of the affected paired piezometers/wells to weekly. The mitigation also includes longer-term actions such as an assessment of the system for potential upgrade or expansion.

For the purpose of determining compliance with the requirement to maintain an inward gradient, the permit specifies for both containment systems that detection of an outward hydraulic gradient would not be a violation of the permit provided that an inward hydraulic gradient is reestablished within 14 days as determined by water level monitoring of the affected paired piezometers and wells.

Conservative calculations submitted by PolyMet indicate that under a "worst case" scenario of an outward-directed hydraulic head difference of two feet at the FTB Seepage Containment System, it would take at least 60 days for water to migrate through the cutoff wall. Reestablishment of an inward gradient within the 14-day timeframe allowed by the permit would not result in an unauthorized discharge. In no case is breaching or overtopping of the containment system authorized.

For the Category 1 Stockpile Groundwater Containment System, the time for water to migrate through the cutoff wall under a "worst case" scenario was conservatively calculated at 21 days assuming a one foot head differential. A lesser maximum head differential was assumed for the Category 1 Stockpile system due to the difference in site materials and characteristics as compared to the FTB system, which reasonably limits the development of a larger head differential. Although the 21 day "worst case" timeframe approaches the 14 day requirement in the permit, it should be noted that the 21 days represents the fastest potential travel time and could only occur under an extreme (i.e., 1000-year) rainfall event. (For comparison, the slowest potential travel time was calculated at approximately 5 years.) For less than extreme events, reestablishment of an inward gradient within the 14-day timeframe allowed by the permit would not result in an unauthorized discharge. To address the potentially faster travel time under an extreme rainfall event, language has been added to the permit for the Category 1 Stockpile system that requires monitoring of water levels from the paired piezometers and wells weekly for three weeks following a 100-year rainfall event. Temporary weekly monitoring after an extreme rainfall event will ensure that the calculated fastest travel time is detected by the monitoring and that no unauthorized discharge occurs. In no case is breaching or overtopping of the containment systems authorized.

Annual assessment to ensure no unauthorized discharges from the Mine Site and Plant Site:
The permit contains special requirements for both an Annual Groundwater Evaluation Report and an Annual Comprehensive Performance Evaluation Report in addition to the permit conditions mentioned above. The purpose of these reports is, in part, to utilize all available monitoring and operating data (including groundwater quality, groundwater elevation, waste stream monitoring and pumping records) to fully evaluate facility performance on an annual basis and to assess whether there is, or is the potential for, a discharge to surface waters. The annual evaluations will provide a comprehensive assessment of the facility engineering controls at the Mine Site and Plant Site in minimizing impacts to water resources downstream of the facility and will require an assessment of potential mitigation options or adaptive management if the potential for an unauthorized discharge to surface waters exists. The Annual Groundwater Evaluation Report and the Annual Comprehensive Performance Evaluation Report are further discussed in the sub-section of the same name below.

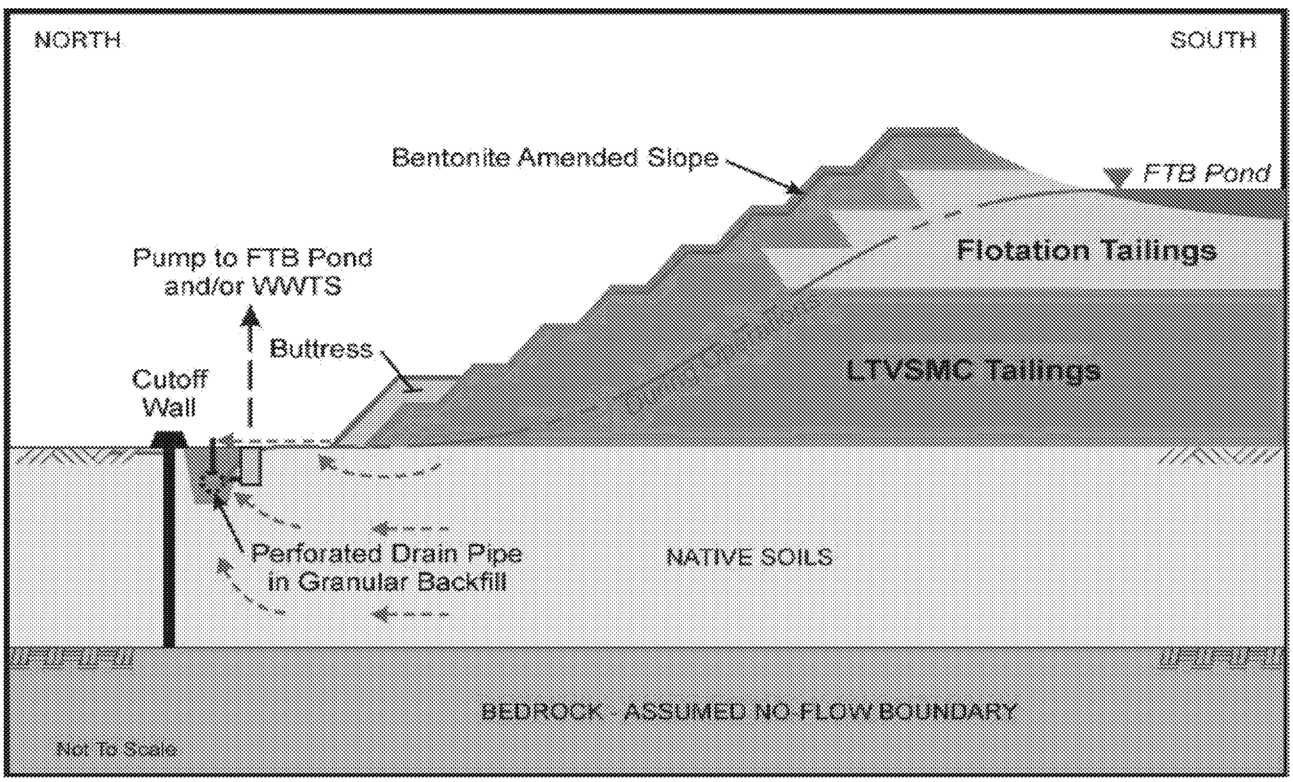
Management of Water During Construction of FTB Seepage Containment System

FTB Seepage Containment System Construction

Seepage from the former LTVSMC tailings basin currently flows to the north and west from the basin as surface seepage or groundwater (deep) seepage. Cliffs Erie currently collects surface seepage, but does not collect groundwater seepage. As part of the Project, all of this seepage will be managed by the FTB Seepage Containment System. The FTB Seepage Containment System will collect seepage along the northern, northwestern, western, and a small portion of the eastern toes of the Tailings Basin dams and route it to the WWTS for treatment and subsequent discharge or to the FTB pond for reuse. Along most of the eastern side of the Tailings Basin, high bedrock will preclude seepage from leaving the basin in that direction, so additional containment is not warranted in those areas. The FTB Seepage Containment System will continue to collect the surface seepage from the basin that is currently being captured by Cliffs Erie, in addition to the seepage from the Tailings Basin that enters the surficial aquifer, runoff from the exteriors of the Tailings Basin dams, and runoff from the small watershed area between the toes of the dams and the containment system.

The FTB Seepage Containment System will consist of a berm and access road through which a cutoff wall (a low permeability hydraulic barrier) will be placed from the surface through the existing surficial deposits to bedrock. A drainage collection system will be installed on the upgradient side, as shown in Figure 11. The drainage collection system will have a collection trench filled with granular drainage material and a perforated drainpipe located near the bottom of the trench. Vertical risers extending above ground surface from the drainpipe will collect runoff and surface seepage occurring upgradient of the FTB Seepage Containment System.

Figure 11 - Conceptual Cross Section: FTB Seepage Containment System (from NorthMet Project Water Management Plan – Plant, Oct. 2017)



The access road will be located approximately 300 to 500 feet from the FTB. During construction, temporary culverts and/or gaps between segments of the containment system under construction will be placed as needed to allow for surface and groundwater to remain hydraulically connected from inside the system to the outside. The number of culverts and/or gaps and their actual locations will be determined in final design. The cutoff wall will not allow seepage to pass through the barrier and will force the runoff and groundwater seepage to be collected in the drainage collection system. Water collected by the FTB Seepage Containment System will be routed to the FTB Pond and/or the WWTS. (See Figures 1-4 below).

Stormwater directly associated with construction of the containment system will be managed as construction stormwater and will be subject to the requirements of the General Construction Stormwater Permit (including development of a SWPPP and application of relevant Best Management Practices). These BMPs will include erosion and sediment control measures, and construction site restoration practices.

During construction of the containment system, surface and groundwater will continue to flow through the gaps/temporary culverts in the road to maintain hydrologic connections in downgradient streams and wetlands during construction. These temporary culverts will be sealed or removed towards the end of the containment system construction and prior to placement of NorthMet tailings in the FTB, with any resulting accumulation of water behind the system routed to the FTB and/or the WWTS.

The permit does not allow PolyMet to deposit nonferrous tailings in the FTB until the FTB Seepage Containment System along the northern and western sides of the Tailings Basin is fully functional. The segment along the eastern side of the Tailings Basin will be constructed concurrently with the east dam, prior to the time that FTB Cells 2E and 1E will merge (currently anticipated to be in approximately Mine Year 7). No seepage is expected along the eastern side of the Tailings Basin prior to the merging of FTB Cells 2E and 1E. The permit does not allow PolyMet to merge Cells 2E and 1E until the portion of the FTB Seepage Containment System on the eastern side of the Tailings Basin is fully functional. A network of monitoring wells and piezometers will be installed along the FTB Seepage Containment System to verify the performance of the system.

The construction schedule for the FTB Seepage Containment System and associated monitoring system will be based on the time of year the NPDES/SDS permit is issued, as well as receipt of all other necessary permits for this work to commence. Two construction seasons will be necessary to install the FTB Seepage Containment System and associated monitoring wells and to conduct verification testing of its performance.

Rationale for managing construction of the FTB Seepage Containment System under the Construction Stormwater General Permit

General permits are authorized under 40 C.F.R. § 122.28 and Minn. R. 7001.0210. MPCA has determined that a general permit is appropriate to regulate discharges associated with construction activity because all construction activity involves substantially similar processes that disturb and expose topsoil and that result in discharges of sediment and potentially other pollutants associated with construction. MPCA is specifically authorized to issue a general permit to any category of point source stormwater discharges by Minn. Stat. § 115.03, subd. 5c (2016).

The primary pollutant that is treated and controlled under the General Construction Stormwater Permit is sediment. Other pollutants associated with construction activities include nutrients, metals, inorganics, pesticides, herbicides, construction chemicals, and petroleum products. These are pollutants from general construction activities, not specifically to the Project, and the Project may not release all of these pollutants. The construction of the FTB Containment System is not expected to encounter or release pollutants not already considered under the General Construction Stormwater Permit.

The quantities of pollutants/pollution potential associated with construction activity vary and are dependent on the type of construction activity conducted at the site, the amount of land disturbance, topography, and the specific operating conditions at the site. Fluctuating rainfall and snow levels will also significantly affect discharge quantities. General permit coverage for construction activities at the Project, including for the FTB Seepage Containment System, addresses these differences by requiring the Permittee to develop and implement a project-specific Stormwater Pollution Prevention Plan (SWPPP) prior to conducting construction activity. The SWPPP requires the Permittee to choose the appropriate Best Management Practices or BMPs to address the potential discharge of sediment and other potential pollutants from the construction site, and to control the indirect pollution and degradation of surface waters resulting from the uncontrolled discharge of volumes of stormwater from impervious surfaces.

Special Permit Conditions for Management of Water during Construction of the Seepage Collection System:

- PolyMet is prohibited from depositing nonferrous tailings in the FTB until the FTB Seepage Containment System along the northern, northwestern, and western sides of the Tailings Basin is fully operating.

- PolyMet shall not merge Cells 2E and 1E until the portion of the FTB Seepage Containment System on the eastern side of the Tailings Basin is fully operating.

- PolyMet shall obtain coverage under the Minnesota General Construction Stormwater permit for construction of the FTB Seepage Containment System. Water encountered during construction of the FTB Seepage Containment System shall be managed as construction stormwater. BMPs for sediment, erosion, and/or dust control are required to be implemented during construction of the FTB Seepage Containment System in accordance with the provisions of the General Construction Stormwater permit.

- PolyMet shall notify the MPCA within 14 days of completion of construction of the FTB Seepage Containment System.

- The Permittee shall notify the MPCA within 14 days of initiation of operation of the FTB Seepage Containment System and the introduction of nonferrous tailings to the FTB.

Attenuation of Legacy Tailings Basin Pollutants

Background

Water quality in the wetlands and other waters downgradient of the existing tailings basin, which LTVSMC operated until 2001, has been affected by ferrous (legacy) surface seepage and groundwater seepage. Baseline monitoring in Mud Lake Creek, Trimble Creek, and Unnamed Creek has documented exceedances of surface water quality standards for several parameters associated with the former ferrous operations, namely total dissolved solids (TDS), specific conductance, alkalinity and hardness.

The MPCA and Cliffs Erie (CE) entered into a Consent Decree in 2010 to address alleged violations of permit conditions at the former LTVSMC site. Surface seepage collection began in 2011 when CE installed pumpback systems at various locations under the terms of the Consent Decree. The pumpback systems collect surface seepage that emerges near the toe of the tailings basin at former outfalls SD004 and SD006 on the west side of the tailings basin, and at Outfall SD026 on the south side. CE then pumps the collected seepage back to the tailings basin pond. Prior to the installation of the pumpback systems, the surface seepage flowed into the headwaters of Unnamed Creek and Second Creek.

The pumpback systems are effective at capturing and removing surface seepage, but they are not designed to capture the seepage from the existing tailings basin to the surficial groundwater aquifer and are not intended to be permanent. Seepage along the northern, northwestern, and western toes of the existing tailings basin dams eventually upwells/flows to the wetlands adjacent to the basin and that are the headwater sources for Mud Lake, Trimble and Unnamed Creeks. To prevent both surface seepage and seepage to the surficial groundwater aquifer, both that are occurring currently due to legacy conditions and that could be created by the Project, from impacting downstream waters, PolyMet proposes to construct seepage capture systems around the FTB.

The FTB Seepage Containment System will consist of a cutoff wall (a low-hydraulic conductivity barrier) extending through the existing surficial deposits to bedrock, with a drainage collection system installed on the upgradient side. Vertical risers extending above ground surface will collect runoff and surface seepage discharging upgradient of the cutoff wall. The water captured by the containment system will be routed to the FTB or the WWTS for treatment prior to discharge.

When the Project begins operating, the existing legacy seepage and future nonferrous seepage captured by the seepage containment system will no longer contribute to the hydrology of the downstream wetlands and creeks. To obtain the benefits of the seepage capture system while at the same time maintaining the functional hydrology of these downstream waters, the collected seepage will be replaced with treated water from the Waste Water Treatment System (WWTS). The treated water, which will meet all surface water quality standards, will be discharged in a dispersed manner to the headwater wetlands immediately downstream of the capture system in the Trimble and Unnamed Creek watersheds.

The existing seepage collection system installed by CE under the Consent Decree along a portion of the southern side of the existing tailings basin will be upgraded as part of the Project as necessary.

PolyMet's South Seepage Management System will function similarly to the containment system along the northern and western sides. The seepage (primarily consisting of surface seepage at this location) will be collected, routed to the WWTS for treatment with seepage from the FTB Seepage Containment System, and then discharged to Second Creek as augmentation water just downstream of the capture system.

Permitted Action

In the time period after issuance of a permit to PolyMet and before the FTB Seepage Containment System is operational, the existing pumpback systems will continue to be operated in accordance with the Consent Decree between MPCA and CE. MPCA anticipates that CE's obligations under the Consent Decree with respect to the existing tailings basin will be assigned to PolyMet. In any event the obligations concerning operation of the pumpback systems will remain in effect before the FTB Seepage Containment System is constructed and the WWTS begins operating.

Once PolyMet begins operating the FTB Seepage Containment System and starts collecting the existing ferrous tailings basin seepage for treatment at the WWTS with subsequent discharge of treated augmentation water downgradient of the containment system, there will be a beneficial effect on downstream water quality. However, because there will be previously impacted waters attributable to pre-Project conditions remaining in waters downgradient of the containment system (both wetland water at the surface and deeper seepage that has yet to up-well into surface waters), there will be a period of time following the startup of FTB Seepage Containment System and WWTS before the pollutants in downstream waters are fully attenuated. In other words, there will be a lag in time before PolyMet's capture of seepage and discharge of treated water will completely disperse the remaining legacy contaminants presently in downstream waters.

The length of this lag time (which can also be referred to as the residence time) for remaining legacy pollutants was evaluated as part of the Project permitting process. The evaluation estimated how long it would take for the remaining legacy pollutants to be fully attenuated at the first (upstream most) surface water monitoring location in each of the three headwater tributaries north and west of the basin under various flow conditions (average flow, low-flow, and high flow conditions). The evaluation indicated that for a flow-through scenario (where the existing wetland water is essentially displaced by the treated water), it would take between 1 and 2 months under high flow conditions and 3-15 months under low flow conditions, depending on watershed, for the downstream water to be fully attenuated. A summary of the results is in Table 15.

Table 15 - Estimated residence time for water in wetlands within the three watersheds

Hydrologic Scenario	Monitoring Location, Subwatershed	Flow-through Residence Time Estimate (months)
Average Conditions	PM-11, Unnamed Creek	3.5
	TC-1a, Trimble Creek	2
	MLC-1, Unnamed (Mud Lake) Creek	2.5
Low-Flow Conditions (2)	PM-11, Unnamed Creek	10
	TC-1a, Trimble Creek	3
	MLC-1, Unnamed (Mud Lake) Creek	15
High-Flow Conditions (3)	PM-11, Unnamed Creek	2
	TC-1a, Trimble Creek	1.5
	MLC-1, Unnamed (Mud Lake) Creek	1

(3) Based on a goal of displacing 90% of the legacy water
(4) Based on the 10th percentile modeled flow rate thorough the watershed from the FEIS modeling of the PlantSite
(5) Based on the 90th percentile modeled flow rate through the watershed from the FEIS modeling of the PlantSite

A similar evaluation of residence time was not conducted for the South Seepage Management System and Second Creek because there is not expected to be a significant period of time between when this seepage capture system begins operation and when legacy pollutants in downstream Second Creek are fully attenuated. Unlike the seepage capture systems along the northern and western sides of the tailings basin, the South Seepage Management System will capture almost exclusively surface seepage with a relatively small percentage of the total flow consisting of captured seepage to groundwater. With the much higher flow velocities of surface seepage relative to deep seepage and the limited wetland area downstream of where the treated water would be discharged, attenuation is expected occur quickly and there should be little discernible lag time.

Monitoring of the surface waters downstream of the existing tailings basin is currently being utilized to inform the actions taken under the MPCA-Cliffs Erie Consent Decree. This monitoring will continue during the Project construction and attenuation phases. The portion of the Consent Decree applicable to the former LTVSMC tailings basin, which will be assigned to PolyMet or an affiliate, deals with the legacy impacts from the previous ferrous operation. The Consent Decree will remain the regulatory vehicle for resolving these legacy ferrous impacts near the basin.

The permit includes downstream surface water monitoring requirements for each of the tributaries receiving the discharge from the WWTS beginning once the Project seepage capture systems and WWTS become operational (after approximately 1-2 years of construction) and the legacy contaminants have been attenuated. Based on the evaluation of residence time above, the permit for the Project specifies that the surface water monitoring requirements will commence 18 months after the first discharge from the WWTS. A timeframe of 18 months was selected, rather than the 15 months indicated by the residence time evaluation above, to provide an allowance for the time of year that the WWTS actually begins operating; a discharge commencing in winter will likely exhibit a longer attenuation time than one commencing in summer due to typically lower flow rates in winter. Until that time, surface water monitoring at each of the locations will continue as described above such that the monitoring record will be continuous and will provide the water quality data necessary for determining when the attenuation of legacy contaminants is complete.

The permit requires monitoring of downstream surface waters for the current key parameters of concern (sulfate, bicarbonate, specific conductance, total dissolved solids and copper) once per month with less frequent monitoring (quarterly/semi-annual/annual monitoring) for a wider range of parameters. A summary of the proposed downstream monitoring locations is in Table 16.

Table 16 - Proposed Plant Site Downstream Surface Water Monitoring

Station	Purpose
SW003 (PM-11)	Unnamed Creek downstream of stream augmentation and FTB Seepage Containment System
SW005 (PM-13)	Embarrass River downstream of Tailings Basin to assess changes from background conditions at SW008 after the performance of the FTB Seepage Containment System and stream augmentation
SW006 (TC-1a)	Trimble Creek downstream of stream augmentation and FTB Seepage Containment System
SW007 (MLC-1)	Unnamed (Mud Lake) Creek downstream of swale and FTB Seepage Containment System
SW020 (PM-7)	Second Creek downstream of stream augmentation and FTB South Seepage Management System

Stormwater

The discharge and management of construction stormwater and industrial stormwater for the Project will be regulated under the National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Construction Stormwater General Permit (MNR100001) and the NPDES/SDS Industrial Stormwater General Permit (MNR050000) respectively. Because PolyMet will be required to obtain coverage under these general permits, this individual permit for the Project does not include provisions regulating the direct discharge of stormwater to surface waters.

Construction Stormwater - Construction Prior to Operations

The NPDES/SDS Construction Stormwater General Permit (CSW General Permit) authorizes the discharge of stormwater runoff from construction sites. This permit was reissued on August 1, 2018, and will expire on July 31, 2023. MPCA anticipates that the CSW General Permit will be renewed when it expires.

Coverage under the CSW General Permit is required for construction activity that results in land disturbance of equal to or greater than one acre or a common plan of development or sale that disturbs an area greater than one acre. Coverage under the CSW General Permit is not required for stormwater from construction activities that is routed directly to and treated by a treatment works, as defined in Minn. Stat. § 115.01, subd. 21, that is operated under an individual NPDES/SDS permit with a Total Suspended Solids effluent limit for the treated runoff.

CSW General Permit coverage will be required for the Project for stormwater generated from NorthMet construction prior to initiation of mining operations and operation of the WWTS. PolyMet has proposed to obtain separate CSW General Permit coverage for separate portions of the Project area. Separate coverage will be obtained for:

- Mine Site
- Plant Site (Processing Areas)
- Tailings Basin
- Transportation and Utility Corridors

These areas will have separate Stormwater Pollution Prevention Plans (SWPPPs) under their respective CSW General Permit coverages.

Construction Stormwater – Construction During Operations
PolyMet has proposed to continue construction activities at the Mine Site and Plant Site for a number of years. Areas such as the stockpile or foundation construction as well as Tailings Basin dam lifts will likely continue to take place after the facility initiates operation. Stormwater discharges from ongoing construction activities, that are not otherwise collected for eventual treatment at the WWTS, will be regulated under the CSW General Permits.

Separate CSW General Permit coverage is not required in the following situation:

- stormwater from construction activities is routed to an existing control structure (i.e. WWTS),
- the existing control structure is regulated by the individual NPDES/SDS permit and
- that individual permit includes a TSS limit for the discharge from the control structure.

This NPDES/SDS permit requires PolyMet to apply for and obtain separate coverage under the CSW General Permit for any new or additional construction activities generating stormwater not regulated under this NPDES/SDS permit. New SWPPPs will be required for any new CSW General Permit coverages.

As construction of the site is completed or as construction areas are revegetated/stabilized, stormwater runoff from these former construction areas will either be permitted as industrial stormwater covered under the Minnesota ISW General Permit or will be treated as non-contact stormwater (which does not require permit coverage). Termination of the CSW General Permits for the Mine Site, Plant Site, and Tailings Basin areas will not be authorized until PolyMet has initiated operation of the WWTS. Termination will not be authorized for the Transportation and Utility Corridors until the completion of construction of the infrastructure associated with the railroad, Dunka Road, and the pipeline. These trigger conditions that must be met by PolyMet to request termination of CSW General Permit coverage for a construction activity have been included in this NPDES/SDS permit.

Industrial Stormwater

The NPDES/SDS Industrial Stormwater Multi-Sector General Permit (ISW General Permit) regulates industrial stormwater discharges to surface waters. Discharges of industrial stormwater from facilities having specific Narrative Activities or Primary Standard Industrial Classification (SIC) codes must obtain permit coverage for their ISW activities. The Project falls under the following SIC codes under Sector G: Metal Mining (Ore Mining & Dressing):

- 1021: Active Metal Mining Facilities – Copper Ores
- 1041: Active Metal Mining Facilities – Gold Ores
- 1099: Miscellaneous Metal Ores, Not Elsewhere Classified

The company has requested separate ISW General Permit coverage for the Mine Site, the Plant Site (including the Tailings Basin), and the Transportation and Utility Corridors. The reasons for three separate ISW General Permit coverages rather than a single coverage include:

- The three areas are geographically separate and distinct (i.e., the Mine Site is 6-8 miles separated from the Plant Site)
- Each area discharges industrial stormwater to different receiving waters, and
- The applicable stormwater sectors are not uniform across all three areas

Separate SWPPPs will be required for each of the three areas covered by the ISW General Permits.

The ISW General Permit includes requirements for a number of industrial sectors, each addressing specific industrial activity categories. Sector G of the permit covers metal mining facilities that discharge stormwater contaminated by contact with, or that has come in contact with, any overburden, raw material, intermediate product, finished product, byproduct, or waste product located on the site of the operation. PolyMet will be required to follow the Sector G requirements in the ISW General Permit at the Mine Site and Plant Site, including those related to benchmark monitoring.

Sector P of the ISW General Permit covers stormwater discharges associated with industrial activity from land transportation and warehousing facilities. PolyMet will be required to follow the Sector P requirements for the Transportation and Utility Corridors.

Discharges from active metal mining facilities that are subject to effluent limitation guidelines for the Ore Mining and Dressing Point Source Category (40 CFR pt. 440) are not authorized by the ISW General Permit and are covered under this NPDES/SDS Permit.

Stormwater that contacts overburden or waste rock and that drains to a point source (either naturally or as a result of intentional diversion) or that combines with mine drainage that is otherwise regulated under the Part 440 regulations are likewise subject to 40 CFR pt. 440. Discharges of such stormwater are therefore not authorized under the ISW General Permit and will instead be covered under this NPDES/SDS permit.

This permit does not incorporate any industrial stormwater coverage. All ISW discharges for the three areas of the Project will be covered under their respective ISW General Permits. The company will be required to maintain coverage for industrial stormwater discharges at each of the project areas for the life of the project.

Summary
Stormwater from construction-related activities at the NorthMet Mine Site, Plant Site, Tailings Basin, and Transportation and Utility Corridors will be regulated under the NPDES/SDS Construction Stormwater General Permit (CSW General Permit). For stormwater management prior to operation of the Mine and Plant sites, the CSW General Permit will provide coverage for all construction related activities. This NPDES/SDS permit requires the company to maintain permit coverage under the CSW General Permit for any ongoing construction or to obtain new general permit coverage for any new construction conducted during the life of the Project. There will be no gaps in permit coverage for construction-related activities.

The NPDES/SDS Industrial Stormwater Multi-Sector General Permit (ISW General Permit) will regulate discharges of stormwater related to industrial activities for the Mine Site, Plant Site (which includes the Tailings Basin), and the Transportation and Utility Corridors. Any stormwater that is collected with other wastewater (e.g. mine drainage) or separately routed to the WWTS is regulated under this NPDES/SDS permit. Coverage of stormwater under the ISW General Permit will be required for the life of the Project. There will be no gaps in permit coverage for industrial stormwater related discharges.

Stormwater coverage under the CSW General Permit will be maintained for any ongoing or new construction until construction ceases and the area reaches final stabilization or construction ceases and coverage of the area is obtained under the ISW General Permit. Stormwater coverage under the ISW General Permit will be maintained throughout the life of the Project. By maintaining coverage under both general permits and this individual permit, there will not be any gaps in the regulation of stormwater discharges from the Project.

Model Verification

The permit contains special requirements that provide the means to periodically assess the performance of the probabilistic water quality models developed for the Mine and Plant Sites. This is accomplished by a comparing observed water quality and quantity values from permit-required monitoring against the values predicted by the modelling. The objectives of the model assessment requirements include:

- Direct comparison of observed data against GoldSim-predicted values
- Confirmation that the model assumptions and construct are appropriate for continued use
- Enabling ongoing use of the models by updating inputs to reflect current conditions
- Use in conjunction with other tools to determine necessary management actions (i.e., adaptive management, contingency actions and/or mitigation)

The model verification requirements include both a short-term assessment (annual assessment) and a longer-term assessment (5-year analysis).

The permit requires the submittal of an Annual Model Verification Report that requires a comparison of observed monitoring data collected through the previous year to the values predicted by the GoldSim model as updated with actual inputs (e.g., climate, mine feature dimensions, material movement, waste rock sulfur content, inflow water quantity and quality, etc.). The assessment will focus on the key parameters of flows, sulfate, chloride, copper and nickel but can include other constituents as appropriate. The short-term analysis will include a "backwards looking" component by evaluating whether observed flows and concentrations are within the range of predicted GoldSim values at critical comparison locations (e.g. mine pits, stockpile and seepage containment system sumps, collection ponds, and WWTS influents). It will also include a "forward looking" component by assessing whether the updated predicted future concentrations are within the range of those predicted by GoldSim in previous long-term impact assessments. If any of the observed values are outside of the ranges predicted by GoldSim, the permit requires PolyMet to further assess these values against a series of questions:

- Do the observed values indicate the potential for increased Project impacts?
- Are there indications that the model assumptions were incorrect?
- Are the observed values the result of mine plan changes that were not captured in the relevant GoldSim predictions?
- Are the observed values indicative of potential undesirable or unacceptable future outcomes?

If the answer is "yes" to any of the questions above, the permit requires that PolyMet submit a Work Plan for MPCA approval that proposes actions or responses that will be taken to address any areas of concern identified during the model assessment process. The first Annual Model Verification Report is required to be submitted within 18 months of initiation of operation of the wastewater treatment system and annually after the first report is submitted.

The permit also requires submittal of a Five Year Model Evaluation Report. This longer-term assessment is required to be submitted 180 days prior to permit expiration and be included with the application for permit reissuance. The Five Year Model Evaluation Report will have a broader focus and must include a comprehensive evaluation of the underlying conceptual models (e.g., XPSWMM, ModFlow, Geochemistry) and other supporting mathematical models that are used as inputs to the GoldSim models as updated. The long-term assessment will also require an evaluation of the potential need for adaptive management, contingency actions, and/or mitigation options. Three years after permit issuance (1 ½ years before submittal of the Five Year Model Evaluation Report), the permit requires PolyMet to submit for MPCA approval a Work Plan describing in detail how the Five Year comprehensive evaluation will be conducted and the measures or performance standards against which conclusions on the performance of the GoldSim modeling will be made. The Work Plan must also identify the process for assessing whether the modeling evaluations warrant the need for adaptive management measures, contingency actions and/or other mitigations.

Annual Groundwater Evaluation Report and Annual Comprehensive Performance Monitoring Evaluation Report

The permit requires an Annual Groundwater Evaluation Report (Groundwater Report) to provide an annual evaluation of the groundwater monitoring well data from the Mine Site and Plant Site.

The Annual Groundwater Evaluation Report requires the Permittee to provide:

- A discussion on the statistical methodologies used in the Report and the rationale for their selection.
- An evaluation of the overall suitability of the existing groundwater monitoring network at the Mine Site and Plant Site to adequately monitor groundwater flows from the Mine and Plant Sites, including its ability to detect a potential future groundwater impact to surface water. The evaluation is also required to assess whether any changes to the monitoring network are needed. If the evaluation indicates that changes to the monitoring network are needed, the Permittee shall:
    - Submit with the Groundwater Report a plan, for MPCA review and approval, that describes in detail the changes proposed, including monitoring locations, parameters to be monitored and/or monitoring frequencies.
    - Install any approved monitoring wells within 1-year of approval of MPCA (and any other agencies necessary for well installation).
    - Upon installation of approved monitoring wells, sample the wells for the parameters and at the frequencies identified in the MPCA approval.
    - Data collected from any additional wells installed must be included in the upcoming year's annual report.
- An evaluation of compliance with groundwater standards at the property boundaries of the Mine Site and Plant Site.
- An assessment of spatial distribution of groundwater quality and the current and future potential and timeframe for migration toward or discharge to surface waters from the Mine Site and Plant Site such that, if needed, adaptive management, mitigation or corrective actions can be undertaken prior to the impact occurring.
- The Permittee shall provide an assessment on the potential for a north flow path in the bedrock or surficial aquifer north of PolyMet's property boundary (north of the Partridge River) at the Mine Site. The assessment must provide discussion on whether or not a potential for a north flow path exists and the logic for that determination. If the potential for a north flow path exists, PolyMet must include a plan and schedule for MPCA review and approval for adaptive management or mitigation to prevent this northward groundwater flow. The plan and schedule must include:
    - A detailed description of the specific actions to be taken and how they will prevent a north flow path,
    - A discussion on the timing of implementation of the actions such that a north flow path is prevented before it can occur, and
    - Whether any additional permitting or approvals are necessary prior to implementation.
    - If necessary, the plan and schedule for adaptive management or mitigation must be implemented in accordance with the MPCA-approved schedule.

The annual evaluation of groundwater data and evaluation of the monitoring well network will use a statistical evaluation to identify any potential impacts to groundwater and any potential for a discharge to surface waters from the Mine Site and Plant Site. The annual groundwater evaluation will provide early identification of potential impacts such that adaptive management, corrective actions, or mitigation can be implemented, if needed.

An annual evaluation of engineering controls at the Mine Site and Plant Site is also required by the permit. PolyMet is required to submit an Annual Comprehensive Performance Report (Performance Report) which will provide an annual comprehensive assessment of the ability of the facility engineering controls at the Mine Site and Plant Site to prevent impacts to water resources downstream of the project. The intent of the Performance Report is to identify in a timely manner the potential for unacceptable impacts such that adaptive management, mitigation or corrective actions can be undertaken prior to the potential impact occurring, and before any violation of the permit conditions. The Performance Report requires PolyMet to evaluate all relevant monitoring and performance data, including waste stream monitoring results, surface water monitoring results, and internal operational data. If the evaluation of the facility indicates the engineering controls are not operating as intended or are not providing a sufficient level of controls, the Performance Report must describe in detail the adaptive management or corrective actions that are being done, or will be done to correct the problem, including a schedule for their implementation.

The goal of the engineering controls at the Mine Site and Plant Site is to prevent pollutants from various engineered project features from reaching the groundwater and surface waters. The annual evaluation of groundwater data, surface water data, waste stream data, and internal monitoring data will provide a frequent evaluation of the performance of the engineering controls and the monitoring networks at the Mine Site and Plant Site. An annual evaluation of the engineering controls along with the evaluation of relevant monitoring and performance data will provide early identification of potential impacts from the project and will help determine the need for adaptive management, corrective actions, or mitigation to prevent potential impacts to the groundwater and surface waters.

Adaptive Management / Permit Modification

Throughout the permit, references are made to "adaptive management," "contingency actions," and "mitigation measures" as a means to address issues that may arise as the facility is constructed and operated and as monitoring data is collected and reviewed. Consideration of adaptive management is incorporated into the required components of the various annual reports required by the permit, including the Annual Groundwater Evaluation Report, the Annual Comprehensive Performance Evaluation Report, and the Annual and Five-Year Model Verification reports. It also is part of more specific assessments such as verifying that unauthorized discharges do not occur.

The MPCA relied on its technical review of the permit application and accompanying plans to determine if proposed engineering controls and wastewater treatment systems will adequately treat waste from the proposed project such that it will meet applicable state and federal requirements. The MPCA has reviewed the available information, including an engineering review, and concluded the permit conditions can be met and the engineering controls will function as designed. Adaptive management is regularly used in complex environmental scenarios to ensure standards are met while allowing flexibility, particularly for facilities yet-to-be constructed where potential issues, and resolutions, cannot be precisely defined ahead of time. The incorporation of adaptive management as a failsafe does not invalidate the requirements for compliance. In this case, the underlying requirements must be met; the adaptive management is intended to develop strategies to maintain compliance.

To address concerns related to the use of adaptive management remedies and the requirements in Minnesota rule related to public notice and participation, language similar to the following has been added to the sections of the permit that specify the inclusion of adaptive management in required evaluations and reports:

> "All proposed adaptive management or mitigation measures are subject to MPCA review and approval. In accordance with Minn. R. 7001.0170, adaptive management or mitigation measures may require a modification of the permit, including a public notice of the proposed modifications."

The MPCA will evaluate any requests to implement adaptive management, contingency actions or mitigation measures against the requirements of Minn. R. 7001.0170 to determine whether a major modification of the permit, with resultant public notice, is warranted.

Hydrometallurgical Residue Facility Construction

PolyMet has proposed to build a Hydrometallurgical Plant to further process the concentrate from the flotation process at the Plant Site. The hydrometallurgical process results in the generation of waste residue that is proposed to be disposed of in the Hydrometallurgical Residue Facility (HRF). The HRF will be constructed in an area adjacent to the Tailings Basin currently occupied by the former LTVSMC Emergency Basin. The Emergency Basin was originally located over a portion of a wetland containing deposits of peat of variable thickness and was originally designed to contain taconite tailings from the main LTVSMC tailings thickeners in the event of a power failure. Existing materials in the Emergency Basin, which will serve as foundation materials for portions of the HRF, include the localized peat deposits as well as hydraulically deposited fine tailings and slimes. These materials have experienced relatively little consolidation since LTVSMC operations ended in 2001.

The HRF is designed to permanently store residue generated from the NorthMet hydrometallurgical process. The HRF is proposed to be constructed to a height of 80 feet with an approximately 300 acre footprint. It is designed to store approximately 6.5 million cubic yards of residue. The HRF will have a double liner system consisting of two barrier layers separated by a leakage collection layer. The upper geomembrane liner will serve as the primary barrier to leakage from the HRF. The lower composite liner will provide a virtually leak-free barrier to prevent any water that passes through the upper liner from leaving the HRF. The Leakage Collection System, to be located between the two liners, will collect any water that passes through the upper liner and pump it back to the HRF Pond. No discharge is allowed from the HRF.

Soil borings conducted to date indicate that the subsurface materials within the Emergency Basin are relatively variable and complex. Variable subsurface conditions can potentially lead to foundation soil settlement and differential settlement, which could adversely affect the integrity and effectiveness of the HRF liner and seepage collection system. To mitigate the potential for differential settlement, PolyMet has proposed to place a preload over the affected area to pre-consolidate the sediments prior to liner placement. The preload will consist of incrementally placing layers of soil and/or rock fill above the existing foundation materials to compress them to specified levels to reduce the risk of excessive settlement and subsequent poor liner system performance during and post HRF construction.

To address concerns about whether the proposed preload effectively addresses the degree of variability within the sediments, as well as to address uncertainties about the nature of the sediments in an area within the HRF footprint not subject to previous soil borings, the Permit requires PolyMet to submit a Preload Design Investigation Work Plan (PDIW) 12 months prior to implementation of the preload. The PDIW requires several plans to be developed and submitted for MPCA review and approval prior to construction of the HRF. PolyMet and MPCA will utilize this planning process to appropriately address the timing, sequencing, and overall schedule for the elements of the preload work. The PDIW includes the following sub-plans:

- *Supplemental Subsurface Investigation Plan (SSIP)*:
  The purpose of the SSIP is to obtain additional information on subsurface soil conditions to

better understand the in-situ soil conditions and refine the HRF preload design to minimize the uncertainty associated with differential settlement. The goal of the SSIP is to ensure that the types of information gathered and methods used to acquire that information will meet the needs of the HRF Preload Plan described in the permit. The SSIP Plan will ensure that the ypes of information gathered and methods used to acquire that information will meet the

needs of the HRF Preload Plan described below. The SSIP must propose investigation and testing methods and locations for additional investigation in the (previously/currently) inaccessible portion of the Emergency Basin where the HRF will be constructed.

- *Working Platform Development Plan (WPDP)*:
  The purpose of the WPDP is to identify and provide details on the proposed methods used to ensure a safe and stable working platform over the soft soils that are present within the Emergency Basin. It will also be used to minimize differential settlement and long-term HRF liner stress due to localized displacement.

Once the HRF site has been investigated and the subsurface conditions characterized, the Permit requires PolyMet to submit for approval a HRF Preload Design Plan (HPDP). The purpose of the HPDP is to incorporate the results of the SSIP and WDP to develop the Design and Specification documents for the preload. The HPDP requires the following information:

- *Design and Specification Documents*:
  The Design and Specification documents must:
  - identify locations where soft soil remediation measures, other than preload, will be used;
  - specify the total proposed consolidation stress that will be applied to foundation soils;
  - where different preload heights and stress levels will be applied, identify theextent of each area and stress level;
  - detail the preload extent and limits along the side slope of the existing tailings basin cell 2W;
  - identify the preload materials and placement methods including constraints on equipment;
  - the geotechnical instrumentation that will be used to determine when pore water pressure dissipation and consolidation settlement is functionally complete; and
  - provide an estimate of preload time required for each area within the HRF footprint.

- *Geotechnical Instrumentation & Monitoring Plan (GIMP)*:
  A Geotechnical Instrumentation & Monitoring Plan (GIMP) is required to be developed and submitted with the HPDP but can be a separate document. The GIMP will be used to determine when excess pore pressures have dissipated within the various soft soil deposits used during the preload construction process. The GIMP is required to identify and provide details on the type, number, and locations of instrumentation used to determine when settlement is functionally complete after preload construction. Quarterly reporting of monitoring results to the MPCA is required by the permit.

- *Wick Drain Plan (WDP)*:
  The Permittee may choose to propose the use of wick drains to accelerate consolidation settlement. If the Permittee proposes to use wick drains, a Wick Drain Plan (WDP) is required. The WDP requires PolyMet to incorporate results of consolidation tests performed on samples of fine tailing/slimes and peat collected as part of the SSIP and will also be used to develop the

design and specification documents for the HRF Preload Design Plan described below.

HRF Liner Plan (HLP):
A HRF Liner Plan (HLP) discussing necessary design elements is required to be submitted with the HPDP but can be a separate document. The purpose of the HLP is to reduce the potential for liner deformation and distress during construction and operation of the HRF. The HLP must include, at a minimum, the following provisions required for the design:

- If the primary liner is proposed to be exposed, it must be at least 100-mil high density polyethylene (HDPE); any alternative to this design requires MPCA approval;
- the secondary liner must be at least 60-mil HDPE; any alternative to this design requires MPCA approval;
- the design must incorporate a lysimeter under the HRF sump or other suitable monitoring devise located northwest of and proximal to the HRF and within the FTB Seepage Containment System to assess the facility's impact on groundwater quality;
- specifically, the design must include an analysis of the suitability of the proposed monitoring to detect leakage from the HRF; and
- strain gauge(s) or other strain monitoring systems must be included with the liner to monitor and provide assurance that the liner system is not subject to excessive strain.

The MPCA will contract with a qualified third-party geotechnical consultant to provide expertise for the review of the geotechnical aspects of the Preload Design Investigation Work Plan, HRF Preload Design Plan, and associated sub-plans. The geotechnical consultant will review and provide comment, as needed, on the submitted plans, monitoring data, associated reports, and design of the HRF preload. MPCA review and approval of the PDIW and HPDP is required before preload construction activities can begin. Furthermore, removal of the preload and/or initiation of HRF construction (e.g., dam construction, liner installation) is not permitted until MPCA provides written approval to remove the preload; this is also expected to require review from the MPCA's third party geotechnical consultant.

The permit includes a provision that if the MPCA determines, upon its review of the required site investigation and preload analysis described above, that the HRF cannot be constructed at the proposed location without unacceptable impacts, then construction of the HRF at that location is prohibited.

The permit requires an annual assessment of the engineering controls, operational data and water quality data at the HRF to evaluate the effectiveness of the liner and Leakage Collection System to be performed by a licensed professional engineer with the appropriate expertise and licensed in the State of Minnesota. The permit also requires monthly inspections of the HRF Pond and HRF Leakage Collection System by a professional engineer to ensure that the HRF and all engineering controls are operating effectively.

Total Facility Requirements

The Total Facility Requirements chapter in the permit describes standard conditions that must be incorporated in all NPDES permits. Standard conditions specified in Title 40 of the *Code of Federal Regulations* (CFR) 122.41 and 122.42 are incorporated into the Total Facility Requirements chapter and identify standard conditions which include various legal, administrative, and procedural requirements of the permit. The standard conditions include definitions, prohibitions, liabilities, sampling and testing procedures, records retention, notification requirements, operation and maintenance requirements, penalties for noncompliance and other Permittee responsibilities.

Summary of Plan, Report and Work Plan Submittals

A summary of submittals required by the permit is provided in Table 17.

Table 17 – Summary of Required Submittals

Submittal	Due
Sulfate Reduction Evaluation Plan	1 year after permit issuance
Annual Model Verification Report	18 months after initiation of operation of the WWTS; then annually by May 31 of each year following permit issuance
Five Year Model Evaluation Report Work Plan	3 years after permit issuance
Five Year Model Evaluation Report	180 days before permit expiration
Annual Groundwater Evaluation Report	March 31 of each year following permit issuance
Annual Comprehensive Performance Evaluation Report	April 30 of each year following permit issuance
HRF Preload Design Investigation Work Plan	12 months prior to placing fill material for preload construction
HRF Preload Design Plan	60 days prior to placing fill material for preload construction
Equalization Basin Performance Evaluation Report	180 days before permit expiration
Dike Seepage Survey Report	January 31 of each year following permit issuance
Application for Permit Reissuance	180 days before permit expiration

MPCA Mercury Strategy and Mercury Minimization Plan

The permit contains requirements for mercury monitoring from various wastewater sources at the Mine Site as well as the influent and effluent from the WWTS treatment trains. It also requires the submittal of a mercury minimization plan in accordance with the MPCA's mercury strategy. These requirements were added to the strategy in response to the U.S. Environmental Protection Agency's approval of the Minnesota statewide Mercury Total Maximum Daily Load (TMDL) plan. More information on the TMDL can be found on the MPCA internet site at http://www.pca.state.mn.us/wfhy9ef. The monitoring requirements include total and dissolved mercury as well as sampling for TSS at the same time the total and dissolved mercury grab samples are taken. This monitoring will allow for an effective assessment of overall facility performance with respect to the control of mercury.

Cross-Media Analysis

A cross-media analysis was conducted by PolyMet to address potential water quality concerns from dust deposition from the Project. This analysis included air modeling of potential facility-generated dust particles, an evaluation of the potential for release of sulfate and metals from oxidation of the deposited dust, and the resulting potential for impact on the quality of down-gradient waters, including wetlands. PolyMet submitted its Cross-Media Analysis to Assess Potential Effects on Water Quality from Project-Related Deposition of Sulfur and Metal Air Emissions on October 31, 2017, with supplemental information submitted November 29, 2017. The analysis was reviewed by MPCA's technical experts.

Based on its review of the cross-media analysis, the MPCA concluded:

1. The analysis developed a reasonable and protective scenario that showed nomeasurable changes of mercury in water or fish from Project-related air deposition ofsulfur.
2. There will be no exceedances of copper, cobalt, and arsenic Class 2D water quality standards or to any other numeric water quality criteria from Project-related air emissions or the cumulative impact of Project-related air emissions.
3. The Project will not result in any measurable changes to water quality downstream of the Project in the St. Louis River, including downstream locations at Forbes (upper St. Louis River).

MPCA's review of the cross-media analysis did not result in any additional requirements in the NPDES/SDS permit.

Antidegradation in Surface Waters

Antidegradation standards and requirements are found in Minnesota Rules parts 7050.0250 to 7050.0335. Antidegradation standards for bioaccumulative chemicals of concern in the Lake Superior basin (Minnesota Rules 7052.0300 to 7052.0330) also apply. As required by these rules, PolyMet submitted an Antidegradation Evaluation as part of the NPDES/SDS permit application.

The Antidegradation Evaluation and MPCA's subsequent review demonstrate that water quality degradation caused by the proposed Project cannot be avoided, but will be prudently and feasibly minimized, existing and beneficial uses will be protected, and the proposed activity is necessary to accommodate important economic or social changes in the geographic area in which degradation of existing high water quality is expected. The proposed Project will implement the best technology in practice and treatment. Therefore, the MPCA has made a preliminary determination that the Project will satisfy antidegradation standards in Minnesota Rules 7050.0265, 7052.0300, and 7052.0330.

MPCA's review of the Antidegradation Evaluation is included as Attachment 3 to this Fact Sheet.

Nondegradation in Groundwater

Minnesota Rules part 7060.0500 identifies a Nondegradation Policy applicable to underground waters of the state. To address these requirements, PolyMet submitted a Nondegradation of Groundwater Evaluation as part of the July 2016 NPDES/SDS permit application with subsequent updates to the Evaluation included in the October 2017 updated application.

MPCA's review of the Groundwater Nondegradation Evaluation consisted of two components and was primarily based on information in the July 2016 permit application. The first component was an assessment whether the Project will satisfy the requirements of Minnesota Rule 7060 while the second component was an attached detailed description and assessment of the site hydrogeology incorporating information from sources in addition to information in the application.

Because MPCA's review of the Groundwater Nondegradation Evaluation was completed prior to submittal of the October 2017 updated permit application, the review did not fully capture or acknowledge some of the specific updates that were included in the updated application. For example, MPCA's hydrogeological review recommended installation of an additional monitoring well in a particular hydrogeologically-favorable area at the Mine Site with the result that this well location was included in the updated application and permit. MPCA also incorporated into the permit the hydrogeological review's recommendation on the use of appropriate statistical methods in the review of groundwater monitoring data.

The Nondegradation of Groundwater Evaluation and the MPCA's subsequent review demonstrate that the requirements set forth under Minnesota Rules 7060 for protection of groundwater resources have been satisfied and that the proposed groundwater monitoring included in the NPDES/SDS permit will verify the protection of the groundwater resources. Therefore, the MPCA has made a preliminary determination that the project satisfies the nondegradation standards in Minnesota Rules 7060. Furthermore, the MPCA has determined that even though its review of the Groundwater Nondegradation Evaluation occurred prior to submittal of the October 2017 updated application, its conclusions and preliminary determination would not be different than had the updated information been available.

MPCA's review of the Nondegradation Evaluation is included as Attachment 4 to this Fact Sheet.

Permit Expiration

The permit extends for a period of five years, the maximum allowed.

Attachments

Attachment 1 - Summary of Monitoring Stations and Monitoring Requirements

Attachment 2 – Chemical Additives

Attachment 3 – Antidegradation in Surface Waters

Attachment 4 – Nondegradation in Groundwater

Attachment 5 – Acronyms and Abbreviations

Attachment 1: Summary of Monitoring Stations & Monitoring Requirements

Wastewater Treatment System (WWTS)

WWTS
Surface Water Discharge Monitoring
SD001

Weekly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Arsenic, Total (as As)	500	µg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	TBEL
Arsenic, Total (as As)	1000	µg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	TBEL
Cadmium, Total (as Cd)	50	µg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	TBEL
Cadmium, Total (as Cd)	100	µg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	TBEL
Calcium, Total (as Ca)	Monitor only	mg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	
Calcium, Total (as Ca)	Monitor only	mg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	
Copper, Total (as Cu)	150	µg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	TBEL
Copper, Total (as Cu)	300	µg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	TBEL
Hardness, Calcium & Magnesium Calculated (as CaC03)	Monitor only	mg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	
Hardness, Calcium & Magnesium Calculated (as CaC03)	Monitor only	mg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	
Iron, Dissolved (as Fe)	1.0	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	TBEL
Iron, Dissolved (as Fe)	2.0	mg/L	Daily Max	Jan – Dec	24-hr composite	1 x week	TBEL
Lead, Total (as Pb)	300	µg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	TBEL
Lead, Total (as Pb)	600	µg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	TBEL
Magnesium, Total (as Mg)	Monitor only	mg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	
Magnesium, Total (as Mg)	Monitor only	mg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	
Mercury, Total (as Hg)	1000	ng/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	TBEL
Mercury, Total (as Hg)	2000	ng/L	Daily Max	Jan - Dec	24-hr composite	1 x week	TBEL
Nickel, Total (as Ni)	Monitor only	µg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	
Nickel, Total (as Ni)	Monitor only	µg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	

pH	6.0	SU	Calendar Month Min	Jan - Dec	Continuous	1 x week	TBEL
pH	9.0	SU	Calendar Month Max	Jan - Dec	Continuous	1 x week	TBEL
Specific Conductance	Monitor only	umh/cm	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	
Specific Conductance	Monitor only	umh/cm	Daily Max	Jan - Dec	24-hr composite	1 x week	
Total Suspended Solids (TSS)	20.0	mg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	TBEL
Total Suspended Solids (TSS)	30.0	mg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	TBEL
Zinc, Total (as Zn)	500	µg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x week	TBEL
Zinc, Total (as Zn)	1000	µg/L	Daily Max	Jan - Dec	24-hr composite	1 x week	TBEL
Flow	Monitor only	Mgd	Calendar Month Avg	Jan - Dec	Measurement	1 x day	
Flow	Monitor only	Mgd	Daily Max	Jan - Dec	Measurement	1 x day	
Flow	Monitor only	MG	Calendar Month Total	Jan - Dec	Measurement	1 x day	

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Aluminum, Total (as Al)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Aluminum, Dissolved (as Al)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Antimony, Total (as Sb)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Beryllium, Total (as Be)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Bicarbonates (HCO_3)	Monitor only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Boron, Total (as B)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Chloride, Total	Monitor only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Chromium, Total (as Cr)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Cobalt, Total (as Co)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Fluoride, Total (as F)	Monitor only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Manganese, Total (as Mn)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Selenium, Total (as Se)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Silver, Total (as Ag)	Monitor only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Sodium, Total (as Na)	Monitor only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Thallium, Total (as Tl)	Monitor Only	µg/L	Calendar Month Avg	Jan - Dec	24-hr composite	1 x month	
Solids, Total Dissolved (TDS)	Monitor only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	

Quarterly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Mercury, Dissolved	Monitor only	ng/L	Calendar Quarter Average	Jan – Dec	24-hr composite	1 x quarter	Sample to be taken at same time as TSS

2 x Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Nitrite + Nitrate Total (as N)	Monitor Only	mg/L	Calendar Month Avg	March, September	24-hr composite	2 x year	
Nitrogen, Kjeldahl, Total	Monitor Only	mg/L	Calendar Month Avg	March, September	24-hr composite	2 x year	
Nitrogen, Total (as N)	Monitor Only	mg/L	Calendar Month Avg	March, September	24-hr composite	2 x year	
Phosphorus, Total (as P)	Monitor Only	mg/L	Calendar Month Avg	March, September	24-hr composite	2 x year	

WET Testing							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
WET Testing - Chronic	See Permit Text	TUc	Calendar Quarter Average	Jan – Dec	24-hr composite	1 x quarter	

WWTS

Surface Water Discharge Monitoring

SD002, SD003, SD004. SD005, SD006, SD007, SD008, SD009, SD010, SD011

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Flow	Monitor Only	Mgd	Calendar Month Avg	Jan - Dec	Measurement, Instantaneous	1 x day	Report 1 x month
Flow	Monitor Only	MG	Daily Maximum	Jan - Dec	Measurement, Instantaneous	1 x day	Report 1 x month
Flow	Monitor Only	MG	Calendar Month Total	Jan - Dec	Measurement, Instantaneous	1 x month	

WWTS
Internal Waste Stream - Internal Performance Monitoring (Sulfate, Copper)
WS074

Weekly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Sulfate, Total, as (SO_4)	9.0	mg/L	Calendar Month Avg Intervention	Jan – Dec	24-hr composite	1 x week	Operating Target
Sulfate, Total, as (SO_4)	10.0	mg/L	Average of previous 12 monthly averages	Jan – Dec	24-hr composite	1 x week	Operating Limit
Copper, Total, as (Cu)	9.3	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	Operating Limit
Arsenic, Total (as As)	53	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	Operating Limit
Cobalt, Total (as Co)	5.0	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	Operating Limit
Lead, Total (as Pb)	3.2	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	Operating Limit
Nickel, Total (as Ni)	52	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	Operating Limit
Mercury, Total (as Hg)	1.3	ng/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	Operating Limit

WWTS

Internal Waste Stream Monitoring – Influent to WWTS (from FTB seepage capture systems)

WS015

Weekly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Calcium, Total (as Ca)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Magnesium	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Mercury	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Nickel	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
pH	Monitor Only	SU	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Sulfate	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	
Zinc	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x week	

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Aluminum, Total	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Antimony, Total (as Sb)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Beryllium , Total (as Be)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Bicarbonates (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Boron, Total (as B)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Chromium, Total (as Cr)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Cobalt, Total (as Co)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Fluoride, Total (as F)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Iron, Total (as Fe)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Manganese, Total (as Mg)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Selenium, Total (as Se)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Silver, Total (as Ag)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Sodium, Total (as Na)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Thallium, Total (as Tl)	Monitor Only	μg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	24-hr composite	1 x month	

Quarterly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Mercury, Dissolved (as Hg)	Monitor Only	ng/L	Calendar quarter Max	Jan – Dec	24-hr composite	1 x quarter	
Solids, Total Suspended (TSS)	Monitor Only	ng/L	Calendar quarter Max	Jan – Dec	24-hr composite	1 x quarter	

WWTS

Internal Waste Stream Monitoring – Influent to WWTS (Combined Mine Water Sources)

WS415, WS416

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Aluminum, Total (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Bicarbonates (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Calcium, Total (as Ca)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cobalt, Total (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Iron, Total (as Fe)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Magnesium, Total (as Mg)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Nickel, Total (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
pH	Monitor Only	SU	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Zinc, Total (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	

2 x Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Antimony, Total (as Sb)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Beryllium, Total (as Be)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Boron, Total (as B)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	

2 x Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Chromium, Total (as Cr)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Fluoride, Total (as F)	Monitor Only	mg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Manganese, Total (as Mn)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Selenium, Total (as Se)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Silver, Total (as Ag)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Sodium, Total (as Na)	Monitor Only	mg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Thallium, Total (as Tl)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	

WWTS

Internal Waste Stream Monitoring – WWTS Mine Water Treatment Effluent

WS072, WS073

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Aluminum, Total (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Bicarbonates (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Calcium, Total (as Ca)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cobalt, Total (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Iron, Total (as Fe)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Magnesium, Total (as Mg)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Nickel, Total (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
pH	Monitor Only	SU	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Zinc, Total (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	

2 x Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Antimony, Total (as Sb)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Beryllium, Total (as Be)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Boron, Total (as B)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Chromium, Total (as Cr)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Fluoride, Total (as F)	Monitor Only	mg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Manganese, Total (as Mn)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Selenium, Total (as Se)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Silver, Total (as Ag)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Sodium, Total (as Na)	Monitor Only	mg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Thallium, Total (as Tl)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	

Mine Site

Mine Site
Internal Waste Stream Monitoring – Mine Pit Dewatering
WS401, WS402, WS403, WS404

2 x Monthly Monitoring							
Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Bicarbonate (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Cobalt, Total (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Nickel, Total (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
pH	Monitor Only	SU	Calendar Month Min	Jan – Dec	Grab	2 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Zinc, Total (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Flow	Monitor Only	mgd/MG	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Jan – Dec	Measurement	2 x month	

Mine Site

Internal Waste Stream Monitoring – Waste Rock Stockpiles; Ore Surge Pile

WS411, WS412, WS421, WS422, WS423, WS424, WS425

2 x Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Nickel, Total (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
pH	Monitor Only	SU	Calendar Month Min	Jan – Dec	Grab	2 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x month	
Flow	Monitor Only	mgd/MG	Calendar Month Avg	Jan – Dec	Measurement	2 x month	

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Bicarbonate (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cobalt, Total (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Zinc, Total (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	

Mine Site
Internal Waste Stream Monitoring – Overburden Storage & Laydown Area (OSLA), Construction Mine Water Basin
WS413, WS414

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	

Mine Site
Groundwater Monitoring - Category 1 Groundwater Containment System Performance
GW600, GW601, GW604, GW605, GW608, GW609, GW612, GW613, GW616, GW617, GW620, GW621, GW624, GW625

Monthly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Jan – Dec	Measurement	1 x month

Mine Site
Groundwater Monitoring - Category 1 Groundwater Containment System Performance
GW602, GW603, GW606, GW607, GW610, GW611, GW614, GW615, GW618, GW619, GW622, GW623

Quarterly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan, Apr, Jul, Oct	Grab	1 x month
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan, Apr, Jul, Oct	Grab	1 x month
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan, Apr, Jul, Oct	Grab	1 x month
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan, Apr, Jul, Oct	Grab	1 x month
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Jan – Dec	Measurement	1 x month

Mine Site
Groundwater Monitoring – Surficial Aquifer
GW402, GW403, GW405, GW407, GW408, GW409, GW411, GW412, GW414, GW415, GW416, GW417, GW418, GW419, GW420, GW421, GW422, GW468, GW491, GW492, GW493, GW494, GW495

3 x Yearly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Arsenic, Dissolved (as As)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Bicarbonates (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Calcium, Dissolved, (as Ca)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Copper, Dissolved (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Magnesium, Dissolved (as Mg)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Manganese, Dissolved (as Mn)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Nickel, Dissolved (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
pH	Monitor Only	SU	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month

Annual Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Aluminum, Dissolved (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Antimony, Dissolved (as Sb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Beryllium, Dissolved (as Be)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Barium, Dissolved (as Ba)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Cadmium, Dissolved (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Chromium, Dissolved (as Cr)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Cobalt, Dissolved (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Fluoride, Total (as F)	Monitor Only	mg/L	Calendar Month Avg	Jul	Grab	1 x month
Lead, Dissolved (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Selenium, Dissolved (as Se)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Thallium, Dissolved (as Tl)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Zinc, Dissolved (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month

Mine Site
Groundwater Monitoring – Bedrock Aquifer
GW501, GW502, GW506, GW507, GW512, GW514, GW515, GW516, GW524, GW525

3 x Yearly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Arsenic, Dissolved (as As)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Bicarbonates (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Calcium, Dissolved (as Ca)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Copper, Dissolved (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Magnesium, Dissolved (as Mg)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Manganese, Dissolved (as Mn)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Nickel, Dissolved (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
pH	Monitor Only	SU	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month

Annual Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Aluminum, Dissolved (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Antimony, Dissolved (as Sb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Beryllium, Dissolved (as Be)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Barium, Dissolved (as Ba)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Cadmium, Dissolved (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Chromium, Dissolved (as Cr)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Cobalt, Dissolved (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Fluoride, Total (as F)	Monitor Only	mg/L	Calendar Month Avg	Jul	Grab	1 x month
Lead, Dissolved (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Selenium, Dissolved (as Se)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Thallium, Dissolved (as Tl)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Zinc, Dissolved (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month

Mine Site
Groundwater Monitoring – North Flow Path Surficial Aquifer
GW470, GW471, GW472, GW473, GW477, GW478, GW479, GW499

Monthly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Jan – Dec	Measurement	1 x month

Mine Site
Groundwater Monitoring – North Flow Path Bedrock Aquifer
GW504, GW505, GW508, GW509, GW510, GW517, GW518, GW519, GW521, GW522, GW523

Monthly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Jan – Dec	Measurement	1 x month

Mine Site
Surface Water Monitoring
SW402, SW407, SW408, SW409, SW410, SW411, SW412, SW413, SW414

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Aluminum, Total (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Aluminum, Dissolved (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Bicarbonates (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cobalt, Total (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Nickel, Total (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
pH	Monitor Only	SU	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Zinc, Total (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Flow	Monitor Only	mgd	Calendar Month Avg	Jan – Dec	Grab	1 x month	

2 x Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Antimony, Total (as Sb)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	
Chromium, Total (as Cr)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	
Selenium, Total (as Se)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	
Thallium, Total (as Tl)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	

Plant Site

Plant Site
Internal Waste Stream Monitoring – Flotation Tailings Basin (FTB)
WS001, WS002, WS003

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Calcium, Total (as Ca)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Magnesium, Total (as Mg)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Nickel, Total (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
pH	Monitor Only	SU	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	

Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Aluminum, Total (as Al)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Bicarbonate (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Boron, Total (as B)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Cobalt, Total (as Co)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Selenium, Total (as Se)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	
Zinc, Total (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Apr, Oct	Grab	1 x month	

Plant Site
Internal Waste Stream Monitoring – Hydrometallurgical Residue Facility (HRF)
WS004, WS005

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Aluminum, Total (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Bicarbonate (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Calcium, Total (as Ca)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cobalt, Total (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Magnesium, Total (as Mg)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Nickel, Total (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
pH	Monitor Only	SU	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Zinc, Total (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	

Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Antimony, Total (as Sb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month	
Barium, Total (as Ba)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month	
Beryllium, Total (as Be)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month	
Chromium, Total (as Cr)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month	

Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Fluoride, Total (as F)	Monitor Only	mg/L	Calendar Month Avg	Jul	Grab	1 x month	
Iron, Total (as Fe)	Monitor Only	mg/L	Calendar Month Avg	Jul	Grab	1 x month	
Manganese, Total (as Mn)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month	
Selenium, Total (as Se)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month	
Thallium, Total (as Tl)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month	

Plant Site
Internal Waste Stream Monitoring – Sewage Treatment Stabilization Ponds
WS009

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
BOD, Carbonaceous 05 Day (20 Deg C)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x week during discharge	
Solids, Total Suspended (TSS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	2 x week during discharge	
pH	Monitor Only	SU	Calendar Month Min	Jan – Dec	Grab	2 x week during discharge	
Fecal Coliform, MPN or Membrane Filter 44.5C	Monitor Only	200/#100 mL	Calendar Month Geo Mean	Jan – Dec	Grab	2 x week during discharge	
Flow	Monitor Only	mgd/MG	Calendar Month Avg	Jan – Dec	Grab	2 x week during discharge	

Plant Site
Groundwater Monitoring – FTB Seepage Containment System Performance
GW202, GW203, GW206, GW207, GW210, GW211, GW214, GW215, GW218, GW219, GW222, GW223, GW236, GW237

Monthly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Jan – Dec	Measurement	1 x month

Plant Site
Groundwater Monitoring – FTB Seepage Containment System Performance
GW200, GW201, GW204, GW205, GW208, GW209, GW212, GW213, GW216, GW217, GW220, GW221

Quarterly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan, Apr, Jul, Oct	Grab	1 x month
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan, Apr, Jul, Oct	Grab	1 x month
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan, Apr, Jul, Oct	Grab	1 x month
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan, Apr, Jul, Oct	Grab	1 x month
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Jan – Dec	Measurement	1 x month

Plant Site

Groundwater Monitoring – Surficial Aquifer

GW002, GW009, GW010, GW015, GW016

3 x Yearly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Arsenic, Dissolved (as As)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Bicarbonate (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Calcium, Dissolved (as Ca)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Copper, Dissolved (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Hardness, Calcium & Magnesium Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Magnesium, Dissolved (as Mg)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Manganese, Dissolved (as Mn)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Nickel, Dissolved (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
pH	Monitor Only	SU	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month

Annual Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Aluminum, Dissolved (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Antimony, Dissolved (as Sb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Beryllium, Dissolved (as (Be)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Barium, Dissolved (as Ba)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Boron, Dissolved (as B)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Cadmium, Dissolved (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month

Chromium, Dissolved (as Cr)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Cobalt, Dissolved (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Fluoride, Total (as F)	Monitor Only	mg/L	Calendar Month Avg	Jul	Grab	1 x month
Lead, Dissolved (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Selenium, Dissolved (as Se)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Thallium, Dissolved (as Tl)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Zinc, Dissolved (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month

Plant Site
Groundwater Monitoring – Bedrock Aquifer
GW109, GW110, GW115, GW116, GW117, GW118, GW119, GW120, GW121

3 x Yearly Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Arsenic, Dissolved (as As)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Bicarbonate (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Calcium, Dissolved (as Ca)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Copper, Dissolved (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Hardness, Calcium & Magnesium Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Magnesium, Dissolved (as Mg)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Manganese, Dissolved (as Mn)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Nickel, Dissolved (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
pH	Monitor Only	SU	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month
Elevation of GW Relative to Mean Sea Level	Monitor Only	Feet	Calendar Month Avg	Apr, Jul, Oct	Grab	1 x month

Annual Monitoring						
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**
Aluminum, Dissolved (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Antimony, Dissolved (as Sb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Beryllium, Dissolved (as Be)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month

Barium, Dissovled (as Ba)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Boron, Dissolved (as B)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Cadmium, Dissolved (as Cd)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Chromium, Dissolved (as Cr)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Cobalt, Dissolved (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Fluoride, Total (as F)	Monitor Only	mg/L	Calendar Month Avg	Jul	Grab	1 x month
Lead, Dissolved (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Selenium, Dissolved (as Se)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Thallium, Dissolved (as Tl)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month
Zinc, Dissolved (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jul	Grab	1 x month

Plant Site
Surface Water Monitoring
SW003; SW005, SW006, SW007, SW008, SW020

Monthly Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Aluminum, Total (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Aluminum, Dissolved (as Al)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Arsenic, Total (as As)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Bicarbonates (HCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Chloride, Total	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Cobalt, Total (as Co)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Copper, Total (as Cu)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Lead, Total (as Pb)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Nickel, Total (as Ni)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
pH	Monitor Only	SU	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Zinc, Total (as Zn)	Monitor Only	µg/L	Calendar Month Avg	Jan – Dec	Grab	1 x month	
Flow	Monitor Only	mgd	Calendar Month Avg	Jan – Dec	Grab	1 x month	

Annual Monitoring							
Parameter	**Limit**	**Units**	**Limit Type**	**Effective Period**	**Sample Type**	**Frequency**	**Notes**
Antimony, Total (as Sb)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	
Cadmium, Total (as Cd)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	
Chromium, Total (as Cr)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	
Selenium, Total (as Se)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	
Thallium, Total (as Tl)	Monitor Only	µg/L	Calendar Month Avg	May, Sep	Grab	1 x month	

Figure 1: Location of WWTS Surface Water Discharge Monitoring Stations SD001 – SD011 and WWTS Internal Waste Stream Monitoring Stations WS015, WS072, WS073 and WS074

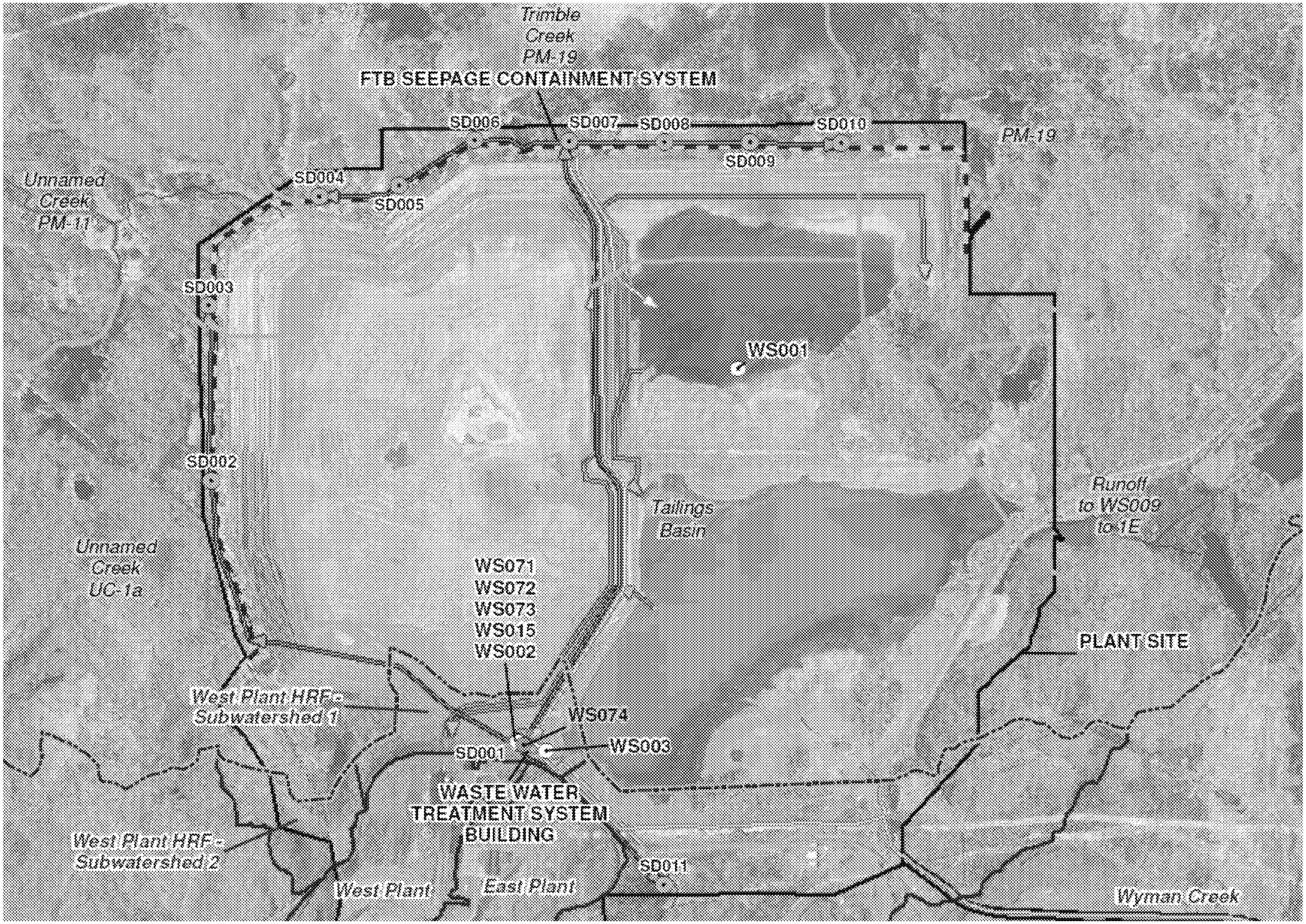


Figure 2: Location of WWTS Internal Waste Stream Monitoring Stations WS415 and WS416

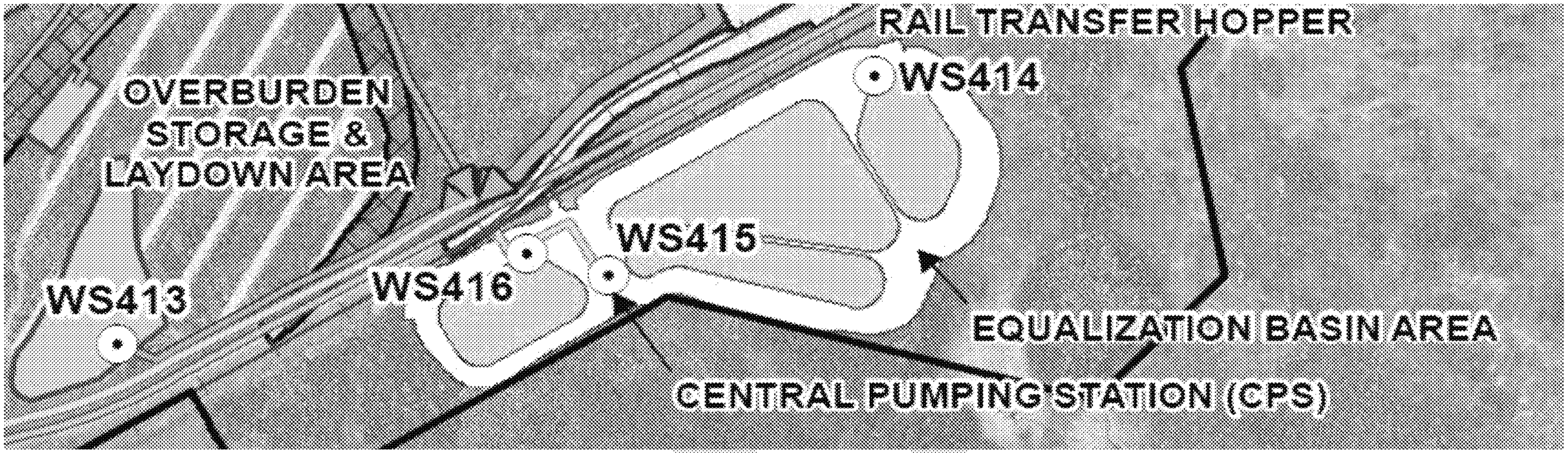


Figure 3: Location of Mine Site Internal Waste Stream Monitoring Stations (WS401-WS404; WS411-WS414; WS421-WS425)

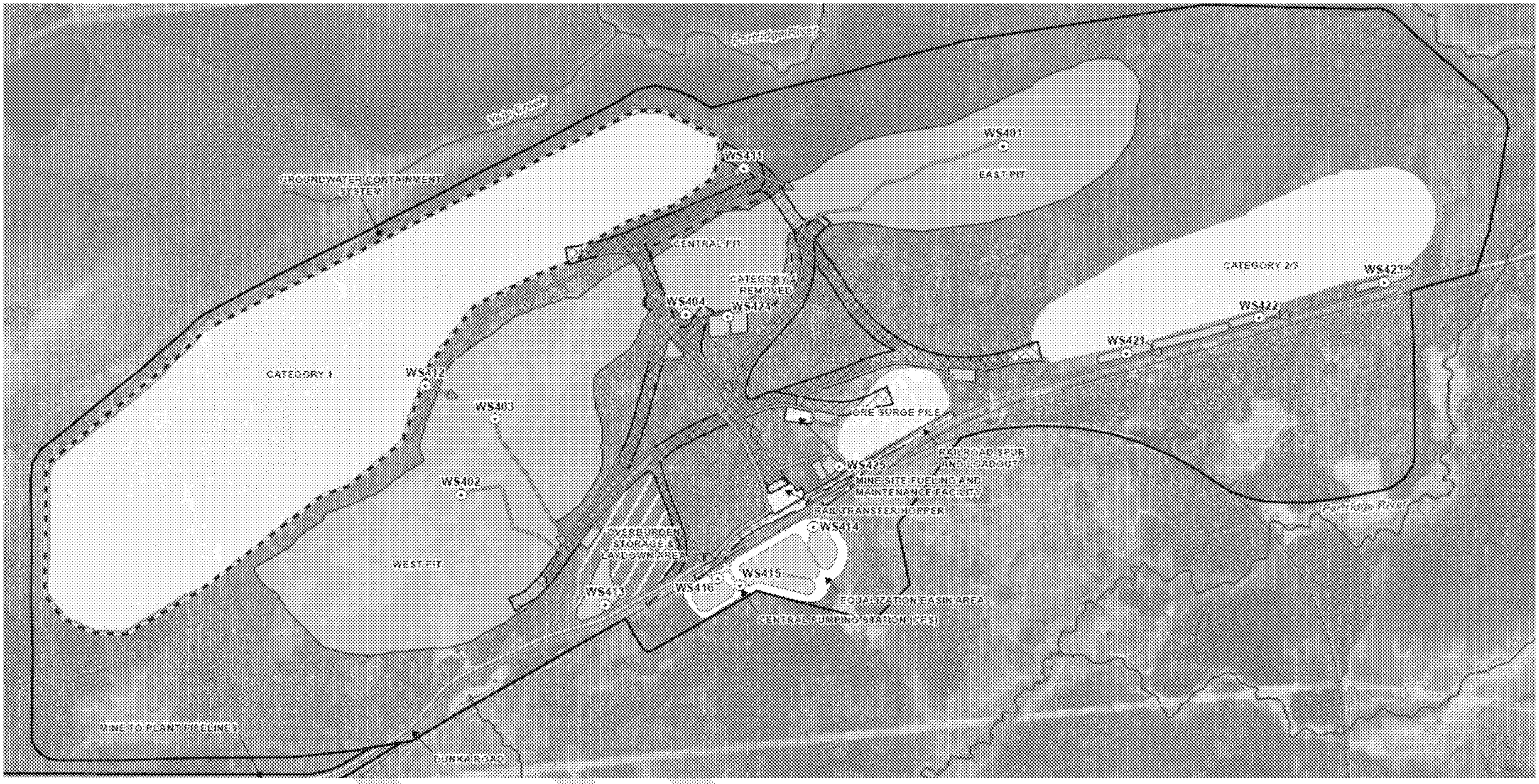


Figure 4: Location of Mine Site Category 1 Groundwater Containment System Monitoring Well & Piezometer Stations (GW600-GW625)

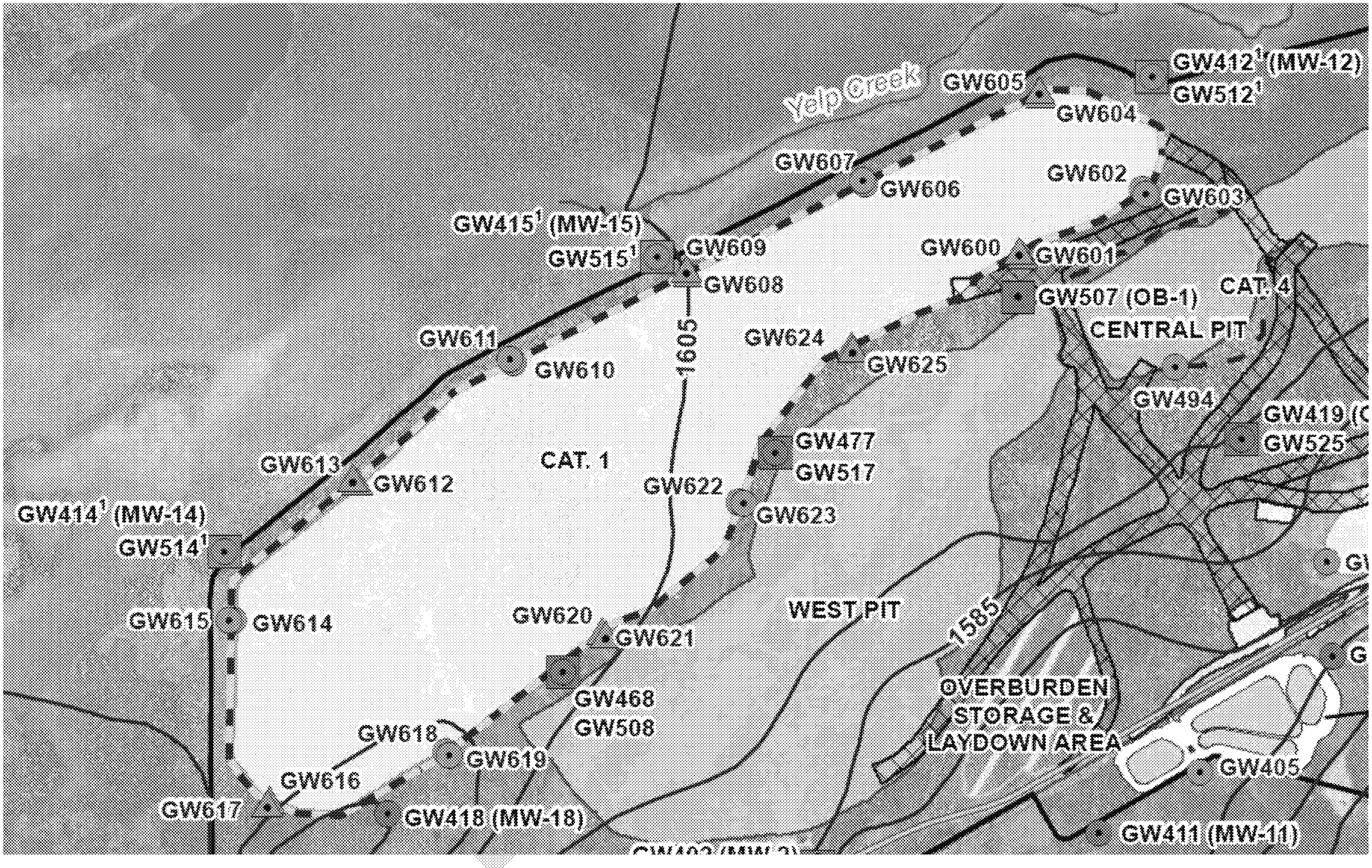


Figure 5: Location of Mine Site Surficial and Bedrock Groundwater Monitoring Well Stations

Groundwater Monitoring – Surficial Aquifer

GW402, GW403, GW405, GW407, GW408, GW409, GW411, GW412, GW414, GW415, GW416, GW417, GW418, GW419, GW420, GW421, GW422, GW468, GW491, GW492, GW493, GW494, GW495

Groundwater Monitoring – Bedrock Aquifer

GW501, GW502, GW506, GW507, GW512, GW514, GW515, GW516, GW524, GW525

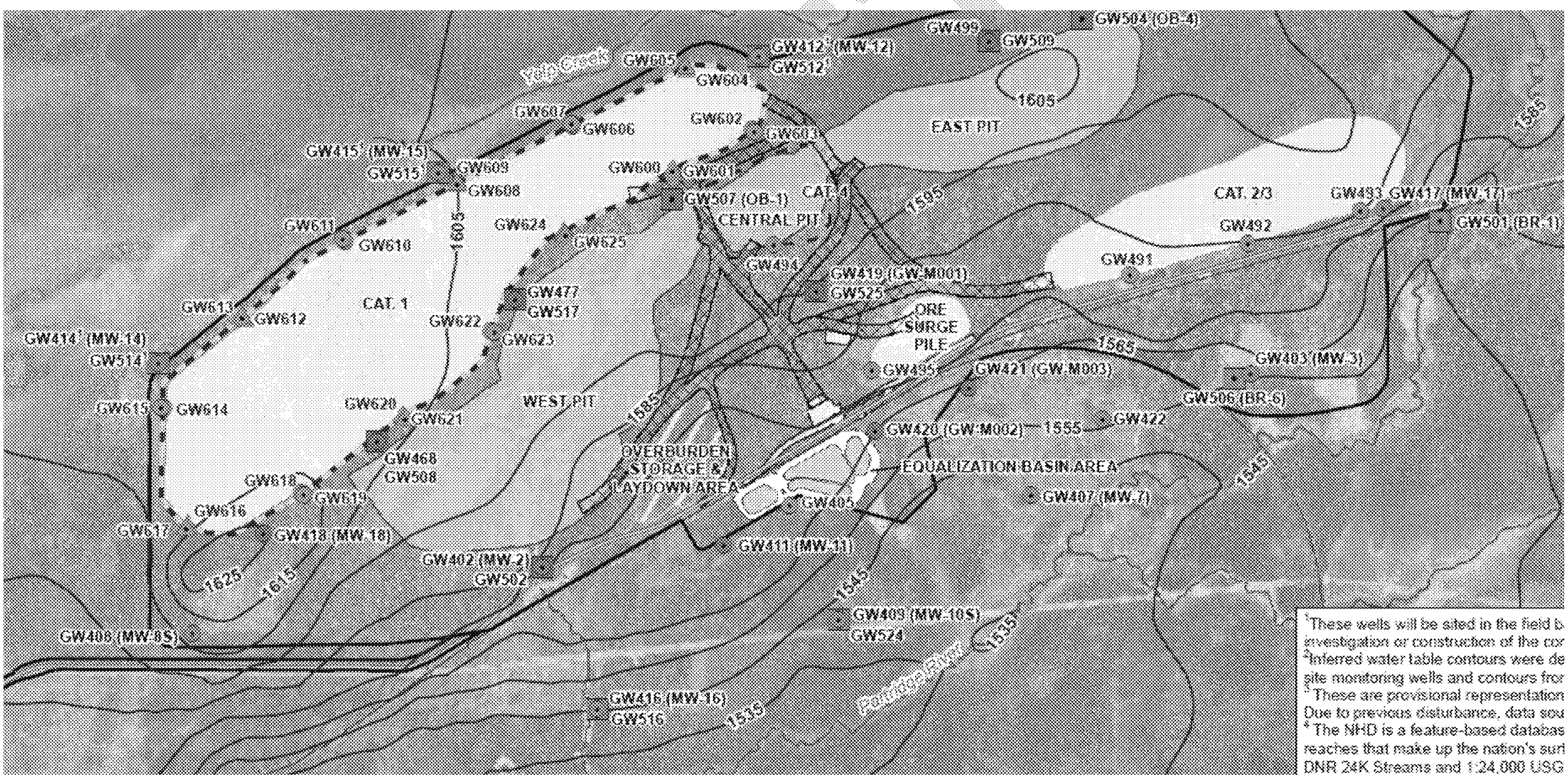


Figure 6: Location of Mine Site Groundwater Monitoring

North Flow Path Surficial Aquifer: GW470, GW471, GW472, GW473, GW477, GW478, GW479, GW499

North Flow Path Bedrock Aquifer: GW504, GW505, GW508, GW509, GW510, GW517, GW518, GW519, GW521, GW522, GW523

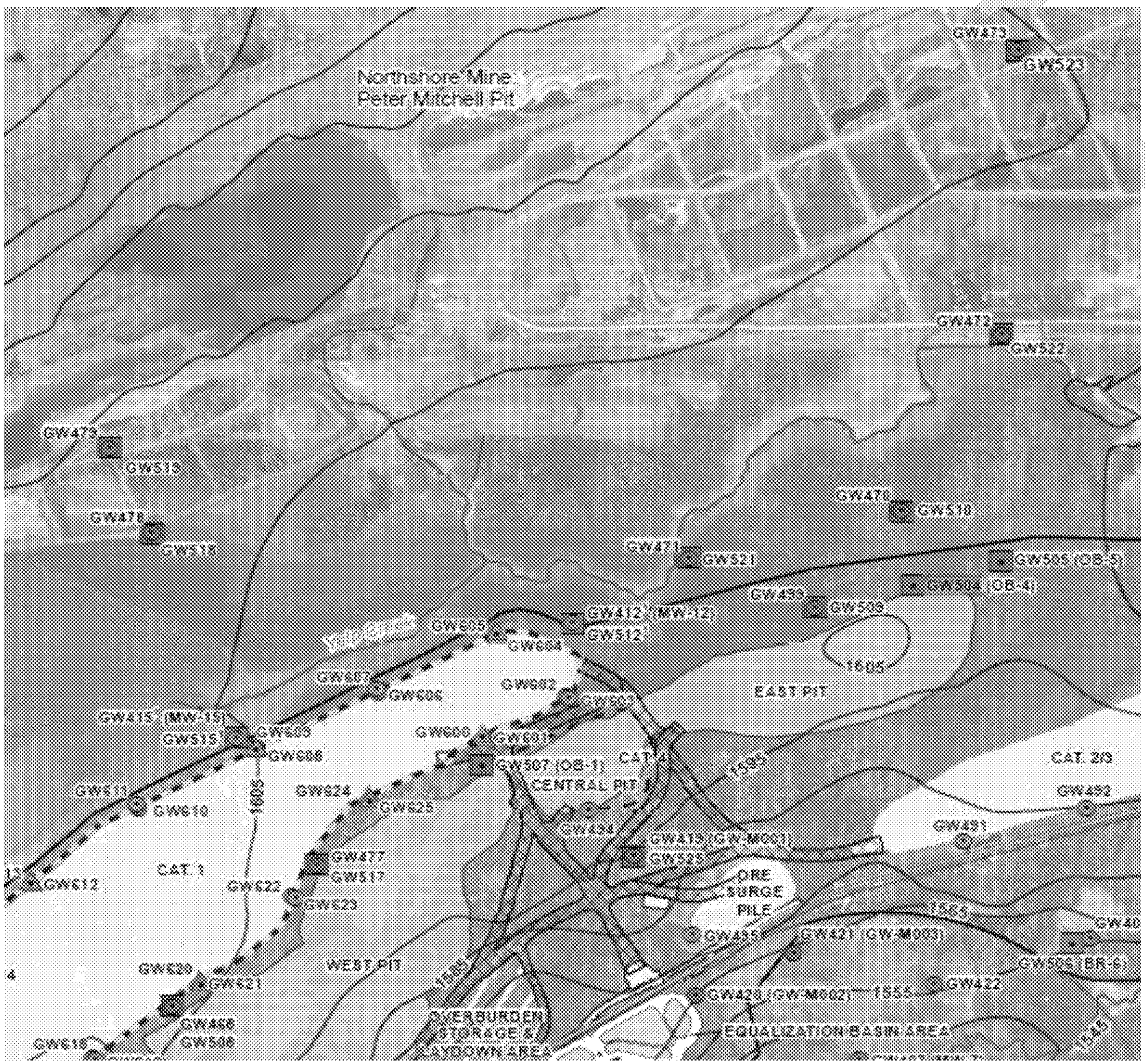


Figure 7: Location of Mine Site Surface Water Monitoring Stations (SW402, SW407, SW408, SW409, SW410, SW411, SW412, SW413, SW414)

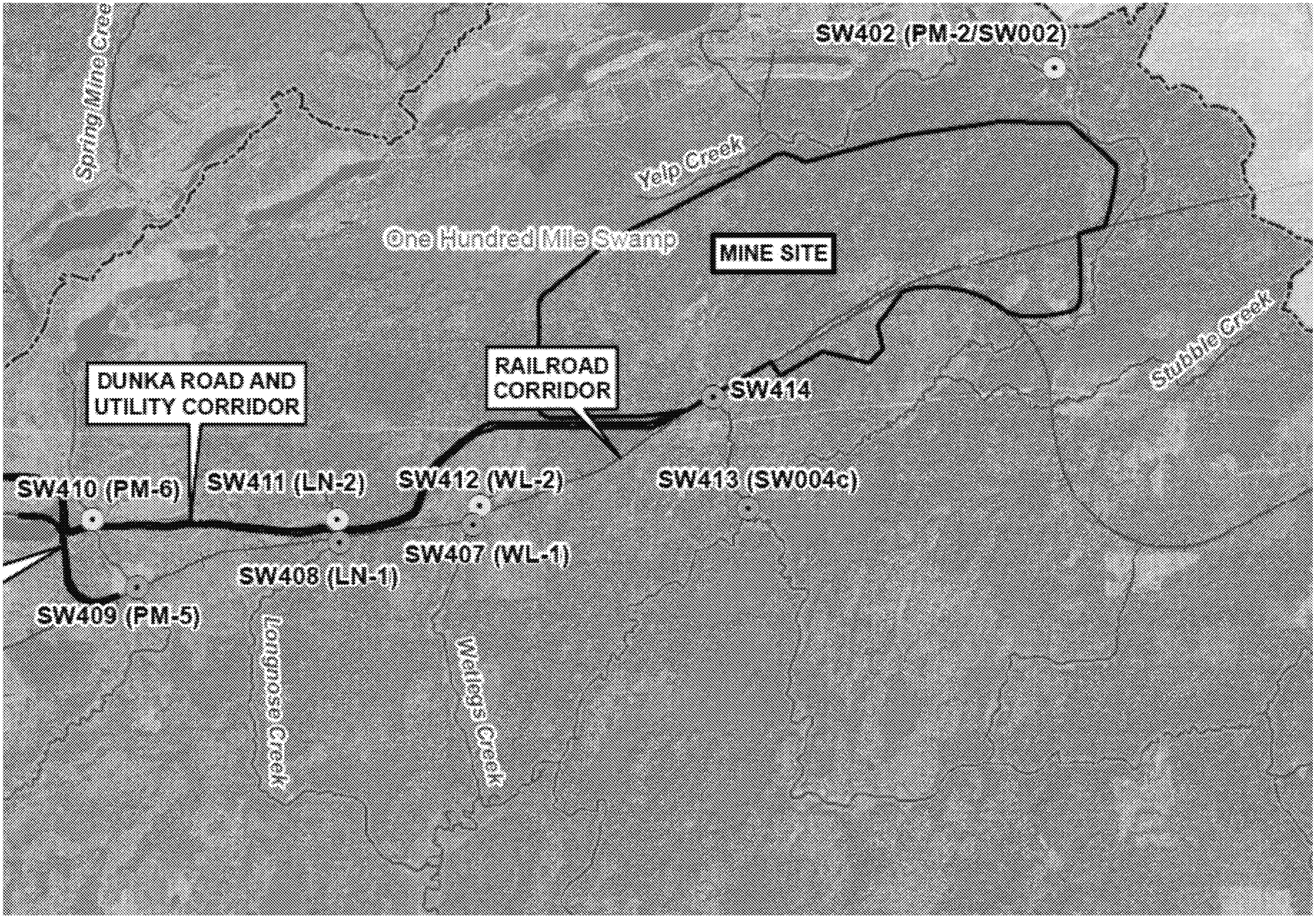


Figure 8: Location of Plant Site Internal Waste Stream Monitoring Stations: FTB, HRF and Sewage Treatment (WS001-WS005, WS009)

Figure 9: Location of Plant Site FTB Seepage Containment System Groundwater Monitoring Stations (GW200-GW223; GW236-GW237)

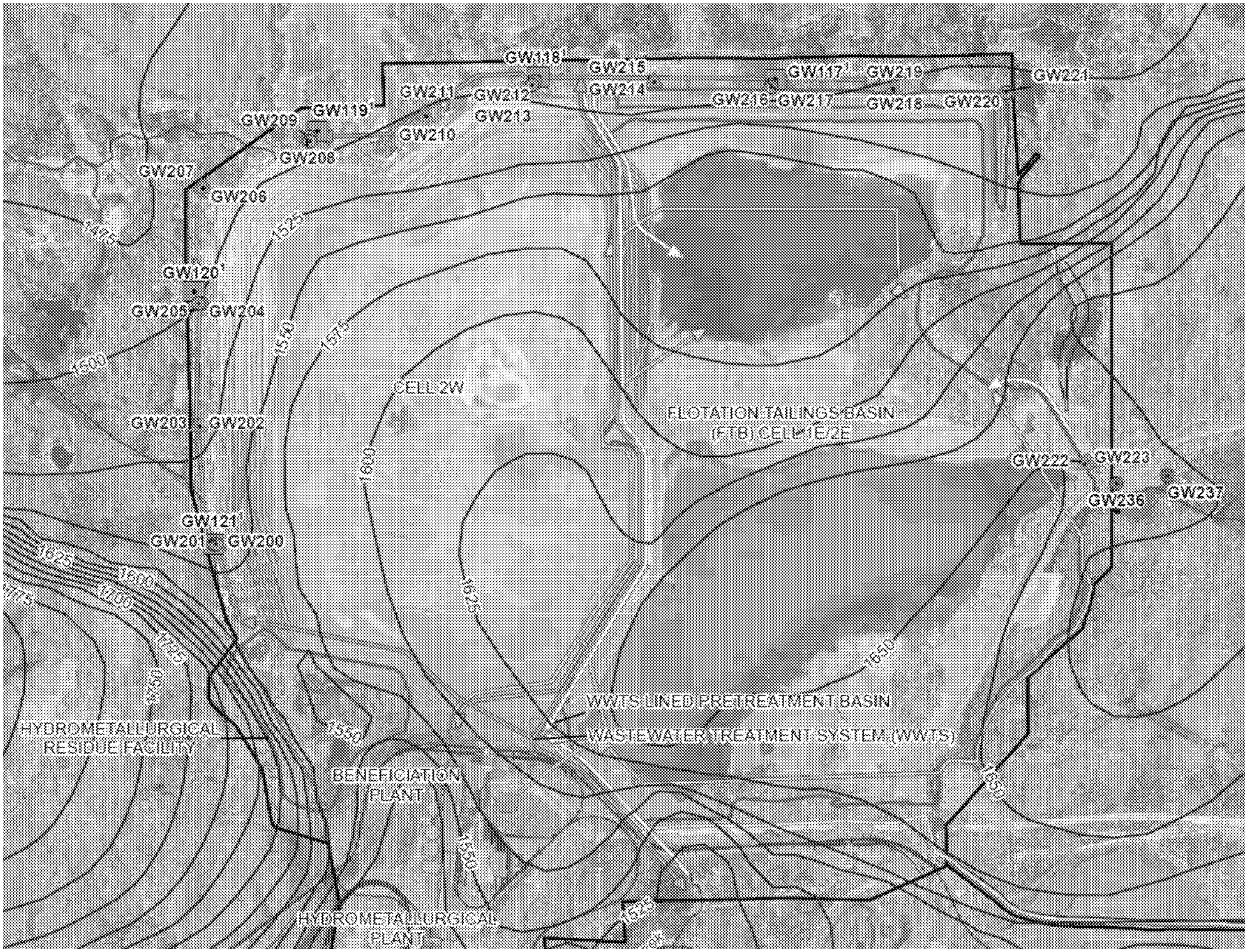


Figure 10: Location of Plant Site Surficial and Bedrock Groundwater Monitoring Well Stations

Surficial Aquifer: GW002, GW009, GW010, GW015, GW016

Bedrock Wells: GW109, GW110, GW115, GW116, GW117, GW118, GW119, GW120, GW121

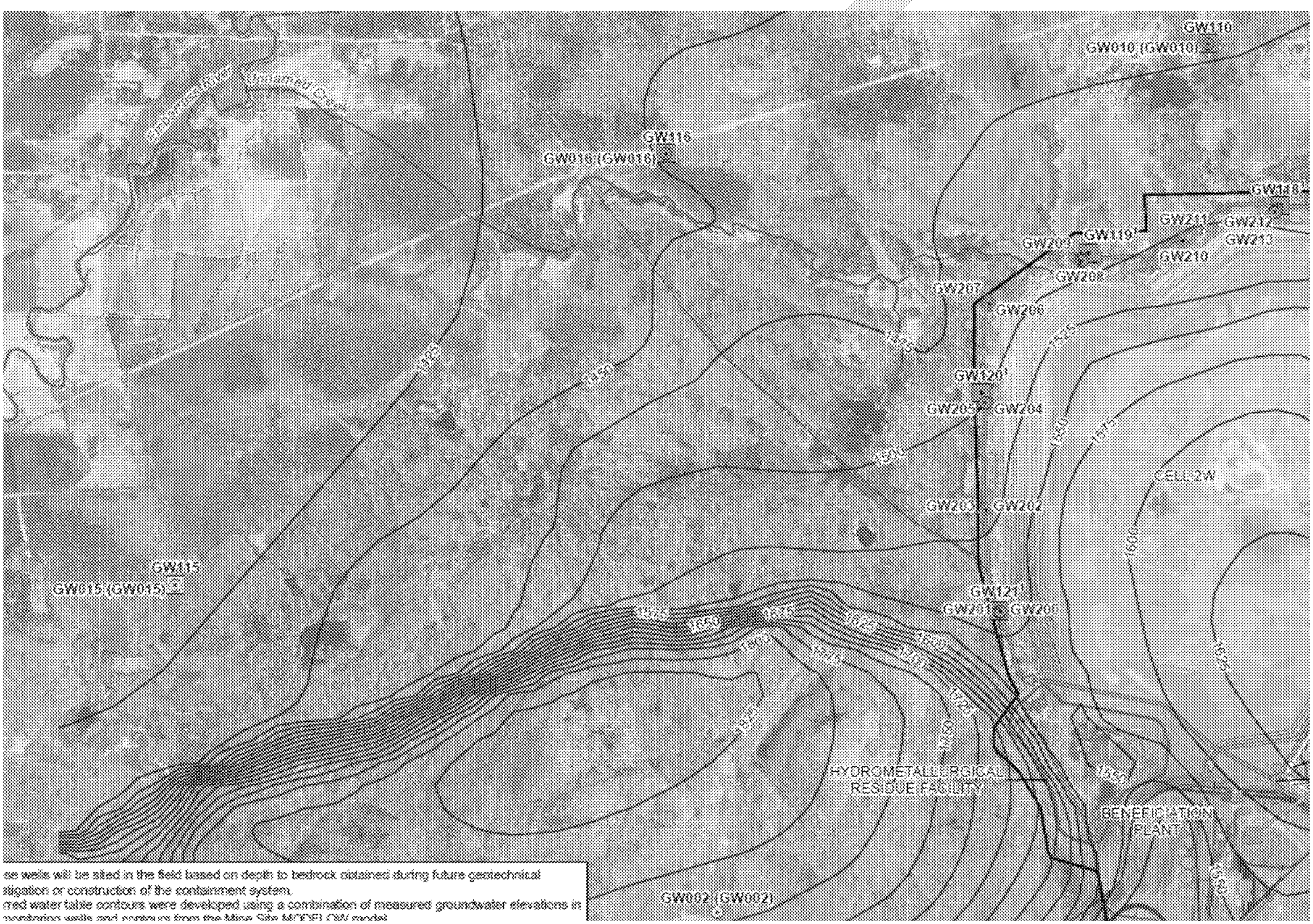
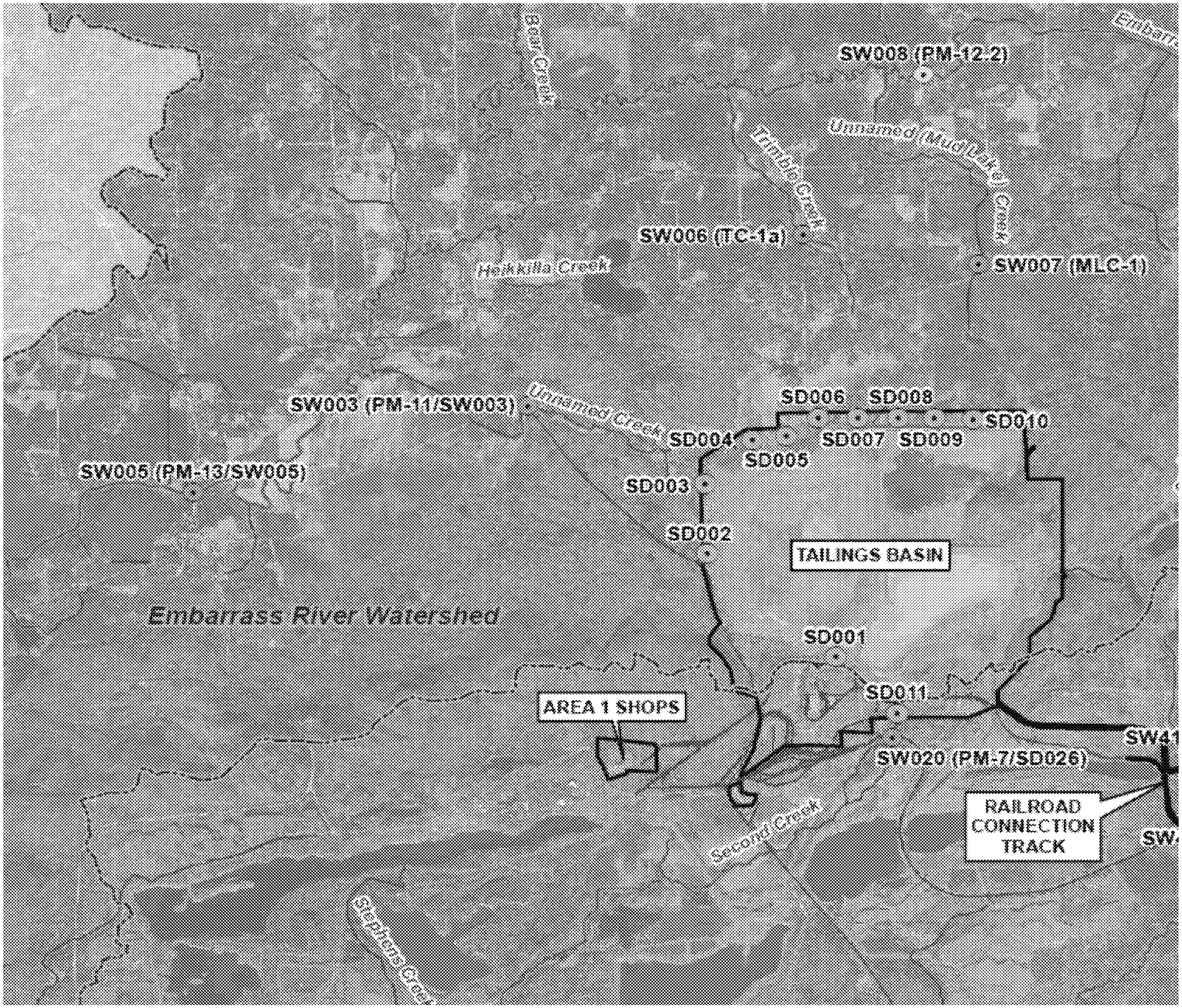


Figure 11: Location of Plant Site Surface Water Monitoring Stations (SW003, SW005, SW006, SW007, SW008, SW020)



ATTACHMENT 2: Chemical Additives

Mine Site

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Magnesium Chloride Aqueous Solution (Dustguard)	Dust Suppressant	Mine Site: Haul roads and stockpiles, if needed	2 -3 times/year	104,428 gallons/day 208,856 gallons/yr	104,428 gallons/day 313,284 gallons/yr
Calcium Chloride	De-icer	Walkways, haul roads	As needed	N/A	TBD based on recommended application rates

Wastewater Treatment System

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Sodium Permangate Solution	Filter Pretreatment	Tailings Basin Seepage Treatment Train greensand filter	Continuous	57 pounds/day	230 pounds/day
Sodium Permangate Solution	Filter Pretreatment	Mine Water Treatment Trains greensand filter	Continuous	12 pounds/day	15 pounds/day
Carbon Dioxide	pH Adjustment	Tailings Basin Seepage Train Secondary Membranes	Continuous	5 tons/day	10 tons/day
Carbon Dioxide	pH Adjustment	Re-carbonation at mine water treatment trains & secondary membranes at mine water treatment trains	Continuous	5 tons/day	5 tons/day
Hydrated Lime	pH Adjustment	HDS metals removal at mine water treatment trains.	Continuous	5 tons/day	5 tons/day
Hydrated Lime	pH Adjustment	Sulfate removal at mine water treatment trains	Continuous	5 tons/day	6 tons/day
Hypersperse MSI410 (Suez)	Membrane Deposit Control Agent	Tailings Basin Seepage Train Primary Membranes	Continuous	59 pounds/day	65 pounds/day
Hypersperse MSI410 (Suez)	Membrane Deposit Control Agent	Mine Water Treatment Trains Primary Membranes	Continuous	11 pounds/day	12 pounds/day
NLR 759	Phosphoric Acid Antiscalant	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	3 gallons/day	3 gallons/day

Wastewater Treatment System

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
NLR 759 (Primary)	Phosphoric Acid Antiscalant	Mine Water Treatment Trains Secondary Membranes	Continuous	4 gallons/day	4 gallons/day
Sodium Bisulfate	Oxidant-Quenching Membrane Pre-treatment	Tailings Basin Seepage Treatment Train Primary Membranes	Continuous	27 pounds/day	39 pounds/day
Sodium Bisulfate	Oxidant-Quenching Membrane Pre-treatment	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	7 pounds/day	7 pounds/day
Sodium Bisulfate	Oxidant-Quenching Membrane Pre-treatment	Mine Water Treatment Trains Primary Membranes	Continuous	5 pounds/day	6 pounds/day
Sodium Bisulfate	Oxidant-Quenching Membrane Pre-treatment	Mine Water Treatment Trains Secondary Membranes	Continuous	3 pounds/day	3 pounds/day
Kleen MCT103 (Suez)	Low pH Reverse Osmosis Membrane Cleaner	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	7,500 pounds/year	8,000 pounds/year
Kleen MCT103 (Suez)	Low pH Reverse Osmosis Membrane Cleaner	Mine Water Treatment Trains Primary Membranes	Continuous	1,600 pounds/year	1,600 pounds/year
Kleen MCT515 (Suez)	High pH Membrane Cleaner	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	7,500 pounds/year	8,000 pounds/year
Kleen MCT515 (Suez)	High pH Membrane Cleaner	Mine Water Treatment Trains Primary Membranes	Continuous	1,600 pounds/year	1,600 pounds/year
NLR 404	Organic Acid Membrane Cleaner	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	10 gallons/day	11 gallons/day
NLR 404	Organic Acid Membrane Cleaner	Mine Water Treatment Trains Secondary Membranes	Continuous	9,000 gallons/year	9,000 gallons/year
NLR 505	Alkaline surfactant Membrane Cleaner	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	10 gallons/day	11 gallons/day
NLR 505	Alkaline surfactant Membrane Cleaner	Mine Water Treatment Trains Secondary Membranes	Continuous	9,000 gallons/year	9,000 gallons/year
Granular Calcite	Effluent Stabilization	Tailings Basin Seepage Treatment Train Limestone Contactor	Continuous	900 pounds/day	2,000 pounds/day

Sewage Treatment Plant & Plant Site Water Treatment

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Magnesium Chloride Aqueous Solution (Dustguard)	Dust Suppressant	Haul roads	2 -3 times/year	98,323 gallons/day 128,691 gallons/yr	98,323 gallons/day 296,469 gallons/yr
Calcium Chloride	De-icer	Walkways, haul roads	As needed	N/A	TBD based on recommended application rates
BT-205W Anionic / Nonionic Surfactant Blend	Dust suppressant	Conveyor transfer points	1 time/year as needed	N/A	
Aluminum Sulfate, 50% Solution	Coagulant	Flocculator	Continuous	47 pounds/day 17,155 pounds/yr	190 pounds/day 69,350 pounds/yr
Potassium Permangate	Oxidant	Flocculator	Continuous	12 pounds/day 4,380 pounds/yr	74 pounds/day 27,010 pounds/yr
Ammonia	Disinfectant (Chloramines)	Clearwell	Continuous (as needed)	0.07 pounds/day 25.55 pounds/yr	02 pounds/day 73 pounds/yr
Chlorine	Disinfectant	Filter and CLearwell	Continuous	0.8 pounds/day 292 pounds/year	2.5 pounds/day 912.5 pounds/year
Liquid Alum	Coagulant	Sewage Treatment System Stabilization Ponds	3 times/year as needed	90 gallons/year	150 gallons/year

Tailings Basin

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Lime Slurry (Primary)	pH Modifier: Used to regulate pH in the flotation circuit	Flotation Circuit, specifically the Separation Cleaner Flotation Cells	Continuous	28.15 tons/day 10,274 tons/yr	41.10 tons/day 15,000 tons/yr
MIBC (Methyl Isobutyl Carbinol, 100% Solution) (Primary)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons/day 1,050 tons/yr)	4.11 tons/day 1,500 tons/yr)

Tailings Basin

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
SIPX (Sodium Isopropyl Xanthate) (Primary)	Collector: Selectively adsorb minerals based on hydrophobicity of the collector & mineral	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Circuit	Continuous	2.74 tons/day (1,000 tons/yr)	4.79 tons/day (1,750 tons/yr)
CMC (Carboxyl Methyl Cellulose Tennapress PE26) Primary	Flocculant: Used to depress gangue minerals in flotation cells to improve selectivity towards Cu Ni minerals	Flotation Circuit, specifically Rougher and Pyrhotite Cleaner Flotation Cells	Continuous	3.29 tons/day 1,200 tons/yr	4.79 tons/day 1,750 tons/year
Copper Sulfate Pentahydrate (Primary)	Activator: Used to increase the available adsorption sites on the mineral to allow for adsorption by the collector	Flotation Circuit, specifically the Scavenger Cells	Continuous	1.71 tons/day 625 tons/yr	2.05 tons/day 750 tons/yr
MagnaFloc 10 (Primary)	Flocculant: Promote flocculation of suspended particles in liquors	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.082 tons/day 30 tons/yr	0.14 tons/day 50 tons/year

Hydrometallurgical Plant & Hydrometallurgical Residue Facility

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Sodium Hydrosulfide, 30% Solution (Primary)	Cementation of copper from solution as copper sulfide	Hydromet, specifically copper cementation	Continuous	3.17 tons/day 1,160 tons/year	4.10 tons/day 1,750 tons/year
Caustic Soda (Sodium Hydroxide, 50% Solution)	Increase pH of off-gases by removing traces of H2S and S02 in vent scrubbers	Hydromet, specifically the plant scrubber	Continuous	57.53 gallons/day 21,000 gallons/yr	82.19 gallons/day 30,000 gallons/yr
Sulfuric Acid, 93% Solution	Used as wash water for leach residue filter	Hydromet, specifically the residue filter wash water	Continuous	0.47 tons/day 170 tons/yr	0.68 tons/day 250 tons/yr
Hydrochloric Acid, 32% Solution	Addition of chloride used to promote mineral leaching	Hydromet, specifically the autoclave	Continuous	13.70 tons/day 5,000 tons/yr	20.55 tons/day 7,500 tons/yr
MagnaFloc 342	Flocculation: Promote flocculation of suspended particles in liquors	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.06 tons/day 21 tons/yr	0.11 tons/day 40 tons/yr

Hydrometallurgical Plant & Hydrometallurgical Residue Facility

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
MagnaFloc 351	Flocculation: Promotes flocculation of suspended particles in liquors	Hydromet, specifically in the leach residue thickener, PGM thickener, and copper sulfide cementation thickener	Continuous	0.27 tons/day 100 tons/yr	0.41 tons/day 150 tons/yr
Sulfur Dioxide (Liquid)	Reduce ferric ions to ferrous ions	Hydromet, specifically iron reduction and PGM precipitation	Continuous	4.14 tons/day 1,510 tons/yr	6.16 tons/day 2,250 tons/yr
Limestone (Lump)	Promote precipitation of Fe and Al	Hydromet, specifically in iron removal	Continuous	276.71 tons/day 101,000 tons/yr	410.96 tons/day 150,000 tons/yr
Limestone (Ground) (Potential substitute)	Promote precipitation of Fe and Al	Hydromet, specifically in iron removal	Continuous	276.71 tons/day 101,000 tons/yr	410.96 tons/day 150,000 tons/yr
Magnesium Hydroxide, 60% Slurry	Promote precipitation of Ni and Co sulfates as Ni and Co hydroxides (mixed hydroxide precipitate)	Hydromet, specifically mixed hydroxide precipitation	Continuous	16.44 tons/day 6,000 tons/yr	24.66 tons/day 9,000 tons/yr
Magnafloc 155	Flocculant: Promote flocculation of suspended particles in liquors	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons/day 40 tons/year	0.21 tons/day 75 tons/year

Transportation and Utility Corridor

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Magnesium Chloride Aqueous Solution (Dustguard)	Dust Suppressant	Haul roads and stockpiles, if needed	2 -3 times/year	49,339 gallons/day 98,678 gallons/yr	49,339 gallons/day 148,017 gallons/yr
Calcium Chloride	De-icer	Walkways, haul roads	1 time/year as needed	N/A	TBD

January 10, 2018

Poly Met Mining, Inc. NPDES Antidegradation Review - Preliminary MPCA Determination

Antidegradation Procedures Overview

Poly Met Mining, Inc. (PolyMet) submitted an NPDES/SDS application for a proposed new discharge. Every NPDES permit authorizing a new NPDES discharge requires completion of antidegradation procedures. The purpose of an antidegradation review is to achieve and maintain the highest possible quality in surface Water of the State (Minn. R. 7050.0250). Antidegradation generally specifies three "tiers" of water quality protection:

- Tier 1 protection requires existing uses and the water quality necessary to support those uses to be maintained and protected – this protection is assured when all applicable water quality standards are met;
- Tier 2 protects existing high water quality, which is water quality that is better than that required by the standards necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water;
- Tier 3 requires the maintenance and protection of water quality necessary to preserve specific water resources of outstanding value.

The antidegradation procedures ensure that Tier 1 protection applies to all waters and standards and that Tier 2 and Tier 3 protection applies where applicable.

Generally applicable antidegradation standards and requirements are found in Minnesota Rules parts 7050.0250 to 7050.0335. Antidegradation standards for bioaccumulative chemicals of concern in the Lake Superior basin (Minnesota Rules 7052.0300 to 7052.0330) also apply. Antidegradation procedures require the permit applicant to prepare an antidegradation assessment or evaluation, and the MPCA to conduct an antidegradation review and make a determination as to whether the antidegradation standards are satisfied.

The antidegradation assessment and review compare projected future water quality (after a proposed new or increased discharge) to existing water quality. This comparison requires knowing the current authorized (as defined by an NPDES/SDS permit) loading of pollutants to the receiving water and projected future loading, and determining if there is a measurable change in water quality. If there is a measurable change, additional action must be taken – such as demonstrating that non-degrading alternatives have been investigated, that degradation is prudently and feasibly minimized, and that degradation is needed to allow for important economic and social development.

As noted in the rule record for the MPCA's recent antidegradation rulemaking, "wastewater treatment facilities must operate under a wide variety of conditions[,] which results in effluent pollutant load and concentration variability." (See Attachment 1 MPCA Detailed Responses to Comments, April 20, 2016, at 46). Therefore, until a new facility is operational, effluent and water quality concentrations can only be a best estimate. Once a facility is permitted, the level of pollution authorized by the permit becomes the baseline for any future antidegradation review.

Any proposals for future changes to the facility must be evaluated to determine if the changes would result in a net increase in loading or other causes of degradation. When a proposal is for new effluent limits because of a new water quality standard or better monitoring data, but those limits are not the result of changes to pollutant loading, antidegradation procedures are not required (see Minn. R. 7050.0255, subp. 26). If a net increase in loading would occur, antidegradation procedures are required and the review begins to look at changes in water quality and proceeds through the rest of the antidegradation procedures.

Summary

PolyMet's Antidegradation Evaluation sought to satisfy the applicable requirements of the rules in both Minn. R. 7050 and Minn. R. 7052. The full Antidegradation Evaluation including tables, figures and appendices discussed in the write-up below can be found in Appendix A of Volume III of the NPDES/SDS application which can be found as Attachment 1 to this document and at the following link: <Link>. PolyMet's Antidegradation Evaluation provided the Minnesota Pollution Control Agency (MPCA) with the necessary information to conduct an Antidegradation review.

PolyMet's Antidegradation Evaluation and MPCA's subsequent review demonstrate that water quality degradation caused by the proposed project cannot be avoided, but will be prudently and feasibly minimized, existing and beneficial uses will be protected, and the proposed activity is necessary to accommodate important economic or social changes in the geographic area in which degradation of existing high water quality is expected. The proposed project will implement the best technology in practice and treatment. Therefore, the MPCA has made a preliminary determination that the project will satisfy antidegradation standards in Minnesota Rules 7050.0265, 7052.0300, and 7052.0330.

While the project will cause degradation for some water quality parameters, the project will also cut off movement of existing polluted groundwater associated with former LTVSMC tailings basin. As a result, the headwaters of Second Creek, Trimble Creek, and Unnamed Creek will experience an improvement in water quality for sulfate and salty parameters.

Background

The project's proposed discharge location is in the headwater areas of Trimble Creek, Unnamed Creek (tributaries to the Embarrass River) and Second Creek (tributary to the Partridge River) in the St. Louis River watershed. The immediate receiving waters for the discharges in the Embarrass River watershed are wetlands which are class 2D, 3D, 4C, 5 and 6 waters. These wetlands drain to Trimble and Unnamed Creeks which are class 2B, 3C, 4A, 4B, 5 and 6 waters. The immediate receiving water for the discharge in the Partridge River watershed is Second Creek, which is a class 2B, 3C, 4A, 4B, 5 and 6 water. All the above-identified waters are located in the Lake Superior basin and are classified as Outstanding International Resource Waters (OIRWs). The nearest downstream restricted Outstanding Resource Value Water (ORVW) – a water where a new discharge is not allowed until there is no prudent or feasible alternative - is Lake Superior. There are no prohibited ORVWs – waters where a new discharge is not allowed – downstream of the project.

Under the antidegradation requirements, all existing uses of each water must be maintained ("tier 1" protection). For the purposes of assuring protective antidegradation requirements, all downstream waters were evaluated by MPCA for Class 2 standards as waters "of high quality" on a parameter-by-parameter basis as defined in Minn. R. 7050.0255 subp. 21. This ensures that the antidegradation procedures provide "tier 2" protection. "Tier 2" protection prohibits the lowering of high water quality unless such resulting water quality is necessary to accommodate important economic or social changes in the geographic area in which degradation of existing high water quality is anticipated. The antidegradation procedures also considered "tier 3" protection for OIRWs and ORVWs. "Tier 3" protection requires that the exceptional characteristics of outstanding resource waters be maintained. The antidegradation procedures for this project also includes mercury, the only bioaccumulative chemical of concern for the Lake Superior basin under Minn. R. 7052.0300 that is present in the proposed discharge.

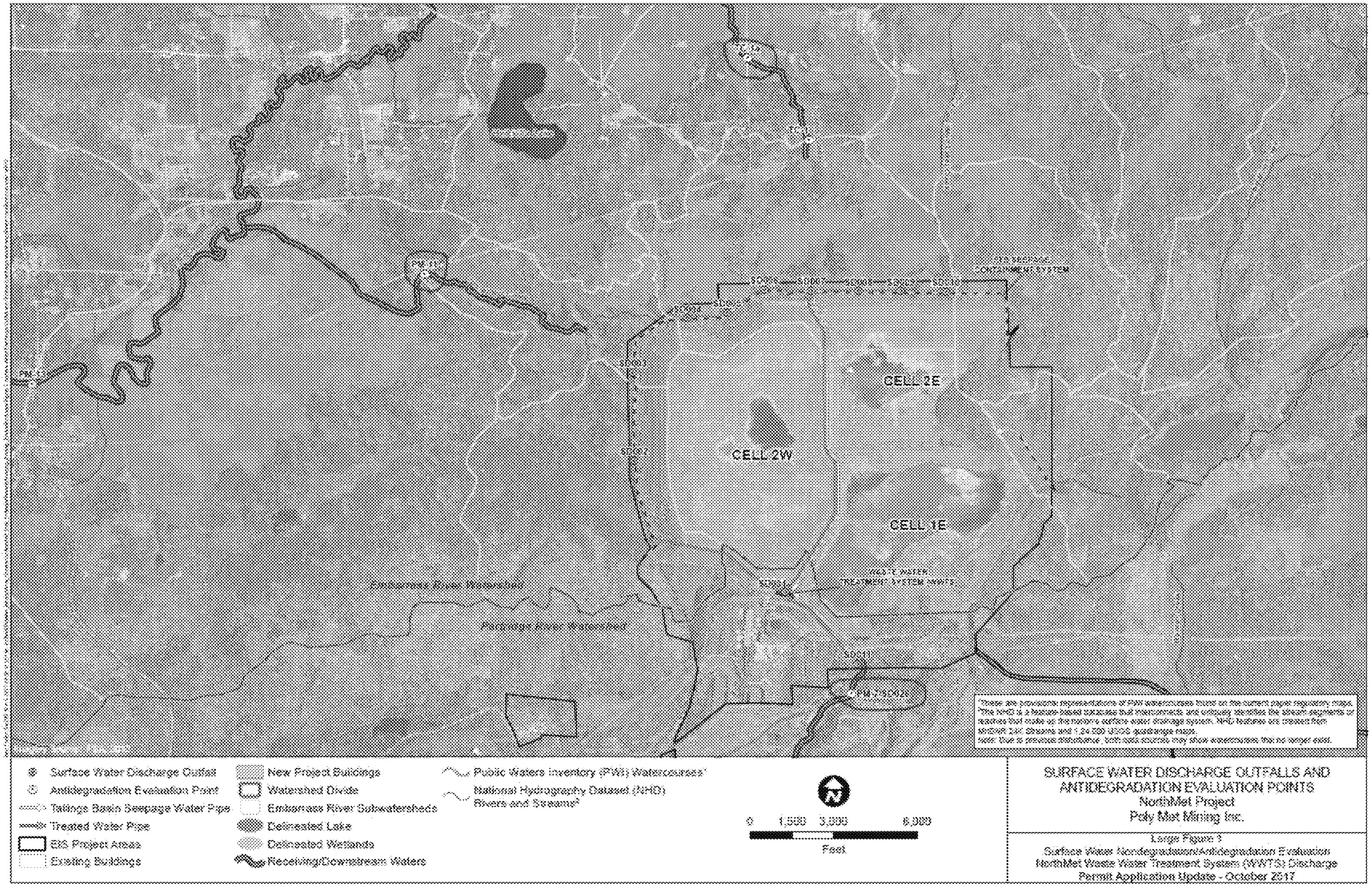
Low flow receiving water conditions represent the period when point sources have the greatest potential to impact receiving water quality. Minnesota Rule 7053.0195, subpart 7, requires control of pollutants from point source dischargers to ensure water quality standards are maintained at specified minimum stream flows. For all parameters of concern for this proposed discharge, the receiving water flow rate required to be protected for is the 7Q10. The 7Q10 is the lowest 7-day average flow that is expected to occur once every 10 years. In this review, the protective receiving water 7Q10 flow rate for all discharge locations is 0.0 CFS because of the headwaters nature of the site location. A 0.0 CFS receiving water flow rate does not allow for any assimilative dilution of discharged pollutants.

The MPCA chose to evaluate surface water degradation at three locations (TC-1a, PM-7/SD026 & PM-11; Map 1 below). These locations had adequate data to determine the existing water quality. The MPCA determined that if degradation was minimized at these three locations, then degradation would also be minimized for all other downstream waters.

Outfall SD001 will be monitored for effluent water quality for compliance at the point of discharge from the wastewater treatment system (WWTS). The effluent is then distributed to three separate headwater receiving water bodies (Unnamed Creek wetlands, Trimble Creek wetlands, and Second Creek), via outfalls SD002 – SD011. Unnamed Creek is characterized by the data from monitoring location PM-11. Trimble Creek is characterized by the data from monitoring location TC-1a. Second Creek is characterized by the data from monitoring location SD026/PM-7. The treated effluent will be distributed to wetlands in the headwaters area of Unnamed Creek on the west side of the FTB via outfalls SD002 and SD003. Treated effluent will be distributed to wetlands to the north of the FTB to the headwaters area of Trimble Creek via outfalls SD004 – SD010. Treated effluent will be distributed directly to Second Creek via outfall SD011.

The remainder of this document summarizes the process of MPCA's review of PolyMet's Antidegradation Evaluation, then demonstrates compliance with each subpart of the applicable antidegradation regulations included in Minn. R. 7050.0265. The rule language of each subpart is followed by MPCA's assessment of how the Antidegradation Evaluation submitted by PolyMet addressed each requirement.

Map 1. Antidegradation evaluation locations used by PolyMet. The locations circled in red are the locations used by the MPCA in this analysis.



Summary of Antidegradation Procedures Process and Definitions

A summary of the antidegradation procedures process is provided in flow chart 1 below. A narrative explanation of each step is after the flow chart.

The general process used in both PolyMet's Antidegradation Evaluation and the MPCA's Antidegradation Review is the same. However, PolyMet's Antidegradation Evaluation relied on FEIS-modeled concentrations from the November 2015 Final Environmental Impact Statement (FEIS) approved by the Minnesota Department of Natural Resources. These FEIS-modeled effluent concentrations provide reliable, protective estimates and are based on ensuring protection of water quality standards. *See* Minn. R. 7050.0280, subp. 3.

PolyMet has also conducted design modeling that projects technologically refined effluent quality based on data collected during bench and pilot testing. This ongoing design modeling confirms that PolyMet can achieve the FEIS-modeled effluent concentrations. As part of its Antidegradation Review, the MPCA chose to also consider the effluent concentrations projected by the design modeling. The design model concentrations are project effluent concentrations based on data, including effluent data, collected during bench and pilot testing and ongoing engineering modeling to scale up the wastewater treatment system design from pilot scale to full-scale. This resulted in more refined projections of future effluent concentrations. Design modeling indicates that concentrations of many of the parameters analyzed may be very close to or below the typical reporting limits; specifically, 12 out of the 21 parameters of concern are projected by the design modeling to be below the typical reporting limit (Table 1 below). Further discussion of the FEIS effluent quality and the design model effluent quality is provided below.

To make an Antidegradation Determination, MPCA considered both the FEIS concentrations provided in PolyMet's Evaluation and the design model concentrations. The FEIS concentrations represent the upper limits of potential effluent quality and the design model concentrations represent an achievable estimate of effluent quality.

The definition of key terms used in the flow chart is below:

Central Tendency: The middle or typical value of a data set. The surface water quality dataset used in this analysis contains a substantial fraction of data points below the detection limit. In such cases, statistics other than an arithmetic average must be used to characterize the "central tendency" of the dataset. An explanation of the methodologies used to calculate the central tendency can be found in Attachment B – Statistical Supplement.

Degradation: "Degradation" or "degrade" means a measurable change to existing water quality made or induced by human activity resulting in diminished chemical, physical, biological, or radiological qualities of surface waters.

Design Model Concentrations: Projected effluent concentrations based on data, including effluent data, collected during bench and pilot testing, and ongoing engineering modeling to scale up the wastewater treatment system design from pilot scale to full-scale. This resulted in more refined projections of future effluent concentrations.

Effluent Concentrations: Projected effluent concentrations from the project, which can refer to the FEIS concentrations and/or the design model concentrations.

Detectable in Effluent: The MPCA defined a value as detectable or not detectable in reference to the typical reporting limits provided in Attachment B, Large Table 1 of the Antidegradation Evaluation. If the projected effluent concentration was greater than the typical reporting limit, then that projected effluent concentration was defined to be detectable. The typical reporting limits provided by PolyMet are consistent with values typically used by the MPCA.

Feasible Alternative: A pollution control alternative that is consistent with sound engineering and environmental practices, is affordable, meets legal requirements, and has supportive governance that can be successfully put into practice to accomplish the task.

FEIS Concentrations: Projected effluent concentrations from the November 2015 Final Environmental Impact Statement (FEIS) approved by the Minnesota Department of Natural Resources.

Measurable Increase: If the projected eflfuent concentration is higher than the 95% UCL of the central tendency, then the effluent concentration will cause a measurable increase in surface water concentration. This definition is the methodology MPCA used to define measurable increase. PolyMet used a different method to define measurable increase.

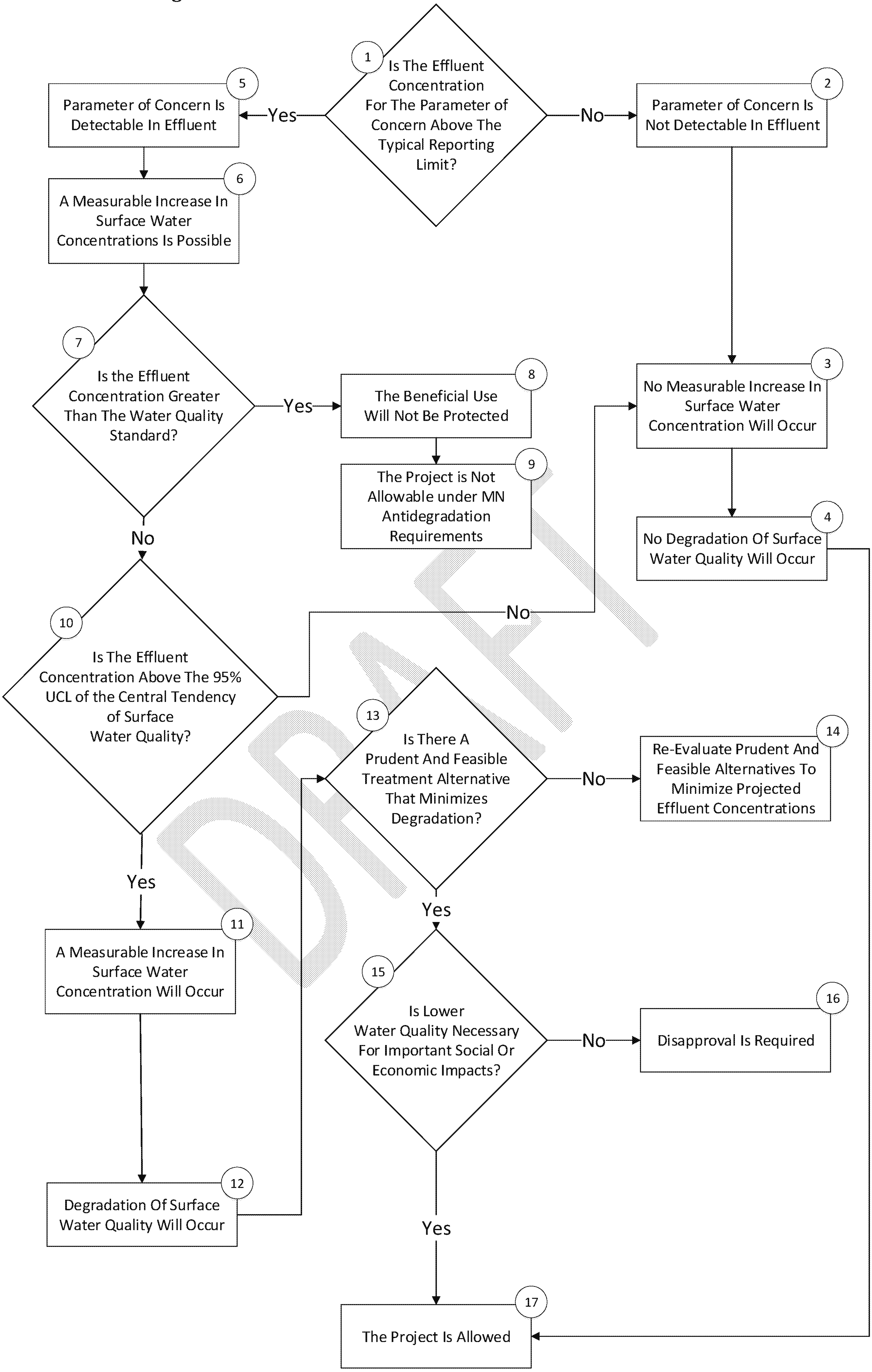
Non-parametric Statistics: A statistical method wherein the data is not required to fit a defined probability distribution.

Prudent Alternative: A pollution control alternative selected with care and sound judgment.

Upper Confidence Limit or UCL: The upper boundary of the 95% confidence interval surrounding the central tendency for the parameter of concern. An explanation of the methodologies used to calculate the UCL can be found in Attachment B – Statistical Supplement.

Typical Reporting Limit: The lowest concentration that a laboratory can accurately measure. PolyMet provided values for each parameter in the Antidegradation Evaluation. MPCA reviewed and confirmed these values were reasonable as typical reporting limits. The typical reporting limits are in Attachment B, Large Table 1 of the Antidegradation Evaluation.

Flowchart 1. Antidegradation Procedures Process



1. Is the projected effluent concentration for the parameter of concern above the typical reporting limit?

All projected surface discharge locations for the project have no surface water assimilative capacity and thus no flow dilution is allowed when considering protection of water quality standards. Because of this lack of dilution, the MPCA made the assumption that the projected effluent concentrations for all parameters of concern will define and ultimately become the surface water quality once the project has initiated discharge.

PolyMet's Antidegradation Evaluation relied on FEIS-modeled concentrations and MPCA also considered the design model effluent concentrations in its antidegradation review. *See* Minn. R. 7050.0280 subp. 3. The MPCA chose to include an evaluation of the design model concentrations because they are more refined than the FEIS concentrations. Many of the concentrations analyzed in this antidegradation review are very close to or below the typical reporting limit. For example, using the design model projected effluent concentrations, 12 out of the 21 parameters of concern are projected to be below the typical reporting limit (Table 2 below). Further explanation of the design model concentrations and the FEIS-modeled concentrations is below.

The MPCA determined that it is not statistically appropriate to evaluate values projected to be below the typical reporting limit using the same logic as values projected to be above the typical reporting limit.

2. The parameter of concern is not detectable

The MPCA defined a value as detectable or not detectable in reference to the typical reporting limits. These values can also be found summarized in Table 2 of this document below.

If the projected effluent concentration was less than the typical reporting limit, then that projected effluent concentration was defined to be not detectable.

3. No measurable increase in surface water concentration will occur

If the projected effluent concentration is expected to be not detectable, then no measurable increase in surface water quality concentrations will occur.

If the projected effluent concentration is expected to be not detectable, then there will also be no measurable increase in mass loading of the parameter of concern.

4. No degradation of surface water quality will occur

If there will be no measurable increase in surface water quality concentrations or mass loading, then by the definition of "degradation," there can be no degradation of existing water quality for the parameter of concern.

5. The parameter of concern is detectable

If the projected effluent concentration was greater than the typical reporting limit, then that projected effluent concentration was defined to be detectable.

6. A measurable increase in surface water concentration is possible

If the parameter of concern is detectable in the effluent using design model concentrations, there is a possibility that a measurable change in surface water concentrations could occur.

7. Is the concentration greater than the water quality standard?

The MPCA defined the reference water quality standards as those in Minnesota Rule 7050 and 7052 as summarized below in Table 2 below and in Table 3-2 of the Antidegradation Evaluation.

8. The beneficial use will not be protected

If the projected effluent concentration is above the water quality standard for any parameter, then the beneficial use would not be protected.

9. The project is not approvable under Minnesota antidegradation requirements

Minn. R. 7050.0265, subp. 4, does not allow for approval of a proposed activity that would permanently preclude attainment of water quality standards. In addition, the commissioner has authority to approve a proposed activity only when existing uses and the level of water quality necessary to protect existing uses are maintained and protected. Minn. R. 7050.0265 subp. 2.

10. Comparing effluent concentrations to surface water quality

This analysis allows for comparison of whether the projected effluent concentration will be outside the estimated central tendency of existing water quality. The basis and rationale for this comparison is described beginning on page 14.

11. A measurable increase in surface water concentration will occur

If the projected design model concentration is higher than the 95% UCL of the central tendency in the receiving water of concern, then the effluent concentration will cause a measured increase in surface water concentration. The rationale for the method used to assess whether a measurable increase occurred is described later in this document.

12. Degradation of surface water quality will occur

If a measurable increase in surface water concentration will occur because of the project, then there will be degradation in surface water quality.

13. Is there a prudent and feasible treatment alternative that minimizes degradation?

A more detailed description of the methodologies used to evaluate prudent and feasible alternatives that minimize degradation is provided on page 14 of this document.

14. Re-evaluate prudent and feasible alternatives to minimize projected effluent concentrations

If the project does not incorporate a prudent and feasible alternative that minimizes degradation, then the proposed alternatives need to be re-evaluated in order to minimize projected effluent concentrations associated with the project.

15. Is lower WQ necessary for important social or economic changes?

Degradation can only be allowed to accommodate important economic or social changes. A description of the methodologies used to evaluate whether the amount of degradation by this project is necessary to accommodate important economic or social changes is found on page 16 of this document.

16. Disapproval is required

If the amount of degradation is not necessary to accommodate important economic or social changes, then the project cannot be approved by the commissioner.

17. The Project is Allowed

The project fulfills Minnesota antidegradation requirements and is allowed.

This box represents the process the MPCA makes to determine whether the lower water quality resulting from the proposed activity is necessary to accommodate important economic or social changes in the geographic area in which degradation of existing high water quality is anticipated.

18. The project satisfies antidegradation requirements

The project is allowable only if compliance with all antidegradation statutes has been demonstrated.

Antidegradation Review Rationale

Antidegradation standards apply

Minn. R. 7050.0265, Subp. 1 – Scope.

This part applies to activities regulated by the following control documents:

A. new, reissued, or modified individual NPDES wastewater permits...

PolyMet has applied for a new NPDES/SDS individual wastewater permit. Thus, the antidegradation standards of Minn. R. 7050.0265 apply.

There will be no physical alteration to surface waters and thus compensatory mitigation is not proposed as a means to preserve an existing use

Minn. R. 7050.0265, Subp. 3 – Compensatory mitigation.

A. The commissioner shall allow compensatory mitigation as a means to preserve an existing use when there is a physical alteration to a surface water only when all of the following conditions are met....

This scope of this review is limited to the NPDES-permitted discharges from the WWTS proposed by PolyMet. The proposed activity addressed in this review will not result in a physical alteration to a surface water and thus, compensatory mitigation as a means to preserve an existing use is not allowed or considered. Issues related to physical alterations of surface waters and compensatory mitigation are addressed in the Section 401 certification antidegradation review.

Existing uses will be maintained and protected and attainment of water quality standards would not be precluded

Minn. R. 7050.0265, Subp. 2 – Protection of existing uses.

The commissioner shall approve a proposed activity only when existing uses and the level of water quality necessary to protect existing uses are maintained and protected

Minn. R. 7050.0265, Subp. 4 - Protection of beneficial uses.

The commissioner shall not approve a proposed activity that would permanently preclude attainment of water quality standards.

Minnesota rules require protection of existing uses and maintenance of the level of water quality necessary to protect those uses (Minn. R. 7050.0265 subp. 2; Minn. R. 7052.0300 subp. 2). To evaluate whether the WWTS discharge will degrade water quality or remove an existing use, MPCA considered the reliable information available, determined the methods of analyzing the data, determined existing water quality, analyzed projected effluent discharges, and determined whether degradation would occur to a degree that would preclude attainment of standards.

Reliable information considered

The MPCA may use the antidegradation evaluation completed by PolyMet or any other reliable information in conducting its antidegradation review. *See* Minn. R. 7050.0280 subp. 3. The MPCA considered the data provided in the Antidegradation Evaluation as well as the supporting documentation.

PolyMet conducted its Antidegradation Evaluation using a set of projected effluent concentrations (Section 3.1.1, Table 3-2, pp. 18-22 of the Antidegradation Evaluation). Figure 1 and Table 1 below show the differences between what are referred to as the FEIS concentrations, which are largely the FEIS concentrations but also include alternate protective values for several parameters as provided in the Antidgradation Evaluation, and the design model concentrations.

Figure 1. Comparison of FEIS and Design Model Effluent Concentrations for Mine Year 10. A "ND" label indicates that the value is less than the typical reporting limit. The sulfate ratio was calculated using the 10 mg/L internal Operating Limit in the draft permit. The design model TDS and specific conductance values were calculated using the same methods in Attachment A of the Antidegradation Evaluation.

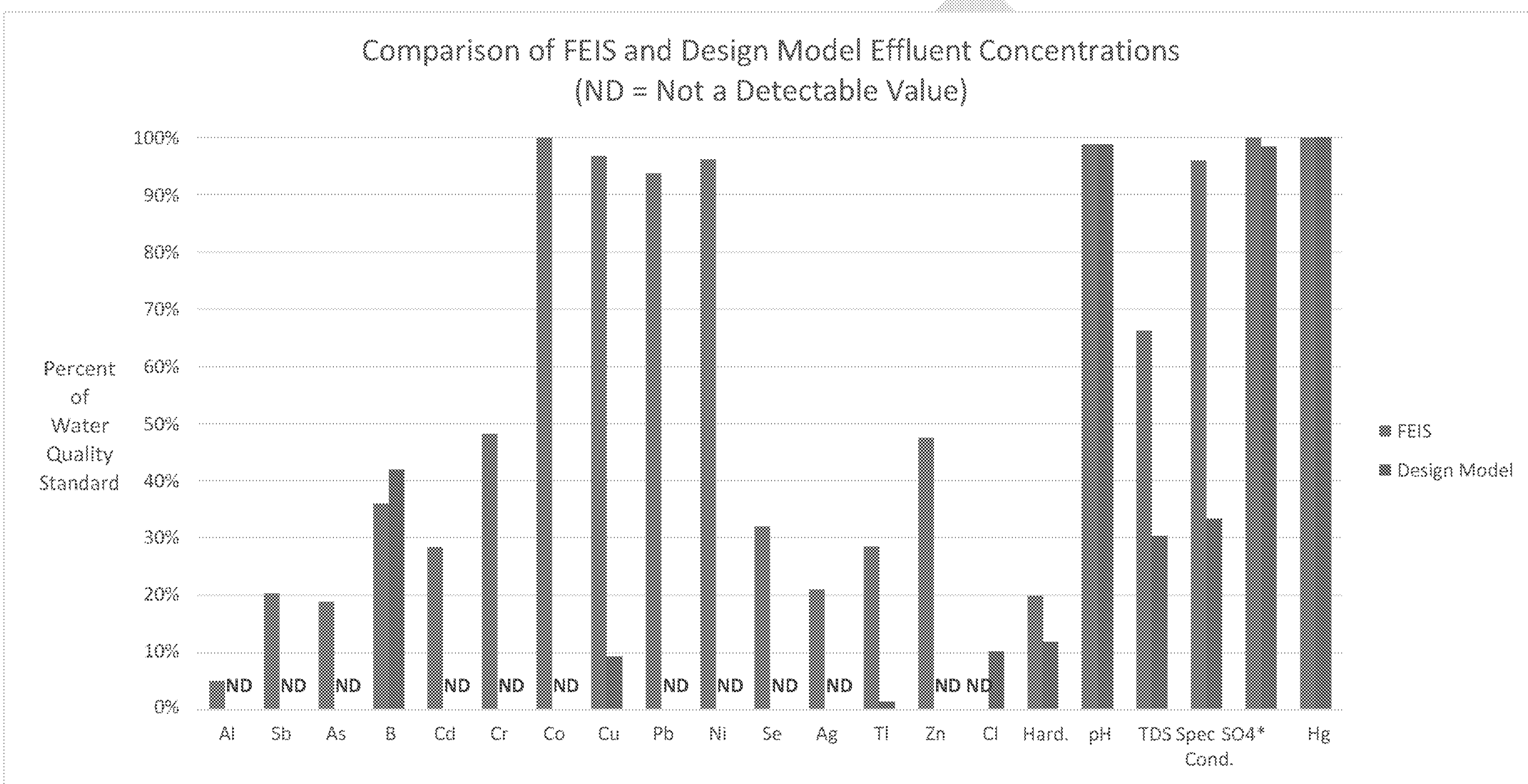


Table 1. Tabular comparison of FEIS concentrations and Design Model concentration in relation to typical reporting limits and the applicable water quality standard.

Parameter	Units	Applicable WQS	Typical Reporting Limit	FEIS Effluent Quality[1]	Design Model Effluent Quality	FEIS Detectable?	Design Model Detectable?
Aluminum (total)	µg/L	125	2	6.3	0.43	Detectable	Not Detectable
Antimony (total)	µg/L	31	0.53	6.3	0.38	Detectable	Not Detectable
Arsenic (total)	µg/L	53	0.5	10	0.004	Detectable	Not Detectable
Boron (total)	µg/L	500	100	230	210	Detectable	Detectable
Cadmium (total)	µg/L	2.5	0.2	0.71	0.056	Detectable	Not Detectable
Chromium (total)	µg/L	11	1	5.3	0.31	Detectable	Not Detectable
Cobalt (total)	µg/L	5	0.2	5	0.011	Detectable	Not Detectable
Copper (total)	µg/L	9.3	0.5	9	0.87	Detectable	Detectable
Lead (total)	µg/L	3.2	0.5	3	0.099	Detectable	Not Detectable
Nickel (total)	µg/L	52	0.5	50	0.14	Detectable	Not Detectable
Selenium (total)	µg/L	5	1	1.6	0.046	Detectable	Not Detectable
Silver (total)	µg/L	1	0.2	0.21	0.059	Detectable	Not Detectable
Thallium (total)	µg/L	0.56	0.005	0.16	0.008	Detectable	Detectable
Zinc (total)	µg/L	120	6	57.1	0.065	Detectable	Not Detectable
Chloride	mg/L	230	5	23.4	23.4	Detectable	Detectable
Hardness (as $CaCO_3$)	mg/L	500	10	100	59.1	Detectable	Detectable
pH	SU	8.5	0.01	8.4	8.4	Detectable	Detectable
TDS	mg/L	700	10	464	213	Detectable	Detectable
Specific Conductance	µS/cm	1,000	0	960	334	Detectable	Detectable
Mercury (total)	ng/L	1.3	0.5	1.3	≤ 1.3[2]	Detectable	Not Detectable
Sulfate*	mg/L	10*	1	≤ 10	9.84	Detectable	Detectable

(1) The concentrations listed here are those used by PolyMet in its Antidegradation Evaluation. They are the FEIS concentrations, with the exceptions of boron, chloride, pH, sulfate and mercury as discussed above. Values for those parameters were revised as a protective assumption for the Evaluation. Additionally, TDS and specific conductance were calculated from the ionic strength using correlations from Snoeyink and Jenkins (1980). See PolyMet's Antidegradation Evaluation Table 3-2.

(2) Mercury concentrations were assumed to be less than or equal to the 1.3 ng/L water quality standard.

*The 10 mg/L sulfate standard is not applicable in the immediate receiving waters; this is an internal Operating Limit in the draft permit.

The distinction between FEIS concentrations and design model concentrations is important in understanding how designated uses and water quality criteria will be protected with the projected discharge.

> **FEIS concentrations** means the projected effluent quality from GoldSim modeling used in the FEIS effects analysis. Conservative/protective assumptions were made in GoldSim modeling regarding the WWTS effluent for the purposes of assessing downstream project impacts in the FEIS. The assumptions were conservative/protective since confidence was high that actual effluent quality would be equal to or better than these assumptions (based on pilot testing and design modeling). The FEIS concentrations are less than or equal to the values reported on EPA Form 2D of the permit application. For its Antidegradation Evaluation, PolyMet made additional conservative/protective assumptions for three parameters (boron, sulfate and chloride), and added protective/conservative values for two other parameters (mercury and pH) that were not included in the FEIS GoldSim modeling. For simplicity, this report includes all five of these parameters within the term FEIS concentrations with footnotes when appropriate (i.e., in tables and figures).
>
> **Design model concentrations** means the projected effluent quality developed by PolyMet based on data, including effluent data, collected during bench and pilot testing. Advanced engineering design modeling was performed using this data to provide detailed engineering information necessary to scale up the wastewater treatment system design from pilot scale to full-scale. Design model concentrations used in this report are for Mine Year 10, which is the year that is expected to have the highest loading to the WWTS. This resulted in refined projections representative of an achievable potential effluent quality. During operations, the actual WWTS effluent quality could vary from the design model results for a number of reasons, including the actual membrane rejection rates over time, compared to the average values used in the design model, and the blend of reverse osmosis and nanofiltration used to achieve the sulfate internal performance target.

The new information obtained for the design model concentrations through more recent advanced engineering design of the treatment system demonstrates that every parameter except for boron, chloride, and sulfate will be treated to equivalent or lower levels than assumed in the FEIS effects analysis. This conclusion is supported by the results of the "Plant Site Wastewater Treatment Plant Pilot Testing" report <Link> and the "Wastewater Treatment System Design and Operation Report"<Link> submitted as a reference to the NPDES/SDS permit application.

The MPCA considered both the FEIS concentrations and the design model concentrations in completing the Antidegradation Review. Figure 1 provides a visual representation of the difference between the FEIS concentrations and the design model concentrations for selected parameters of concern in relation to water quality standards while also considering typical reporting limits.

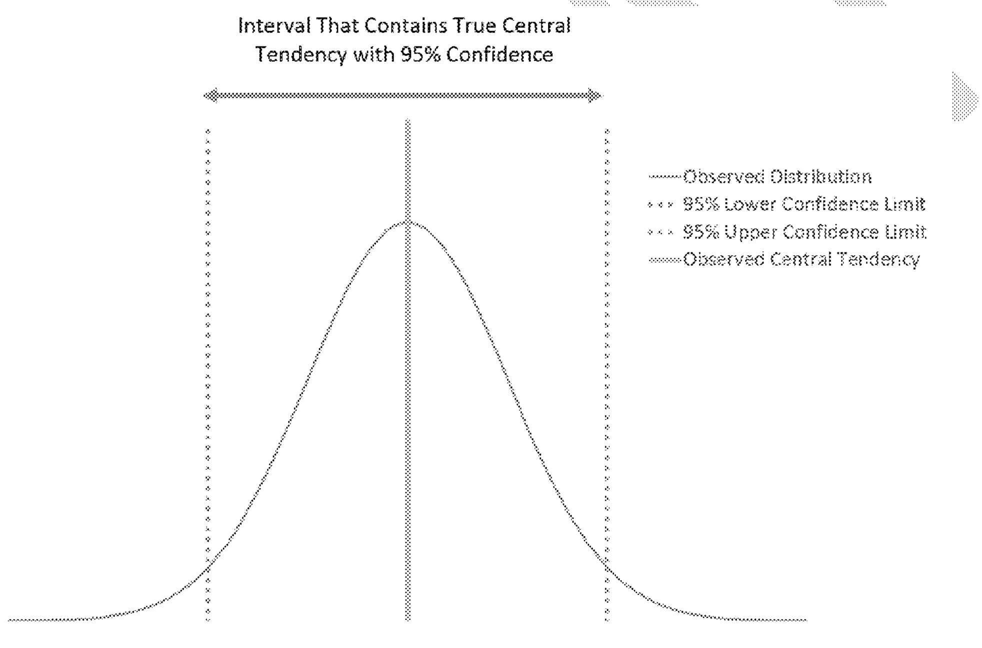
Data analysis methodology

After determining the projected effluent quality, the MPCA reviewed whether effluent of such quality would result in a measurable changed in water quality.

Existing water quality was determined using the methods in Minnesota Rule 7050.0260 (as described in Sections 6.2 (pp. 49-54) and 8.2 (pp. 84-85) of PolyMet's Antidegradation Evaluation) and the potential for a measurable change in water quality was assessed in Sections 6.3 (pp. 54-65) and 8.3 (pp. 85-93) of the Evaluation. Existing water quality was calculated using monitoring data that are sufficient to reflect the conditions of the surface waters. As described below, MPCA characterized existing water quality using the central tendency, more specifically the 95% UCL of that central tendency – the highest value that the central tendency probably remains below with 95% confidence.

The MPCA chose to compare the design model concentrations to the central tendency of the surface water quality because the central tendency is a good indicator of typical water quality. Assessing water quality changes against the central tendency allows a determination of whether there would be any measurable changes in typical water quality. The true central tendency of surface water quality should not be thought of as a single value, but rather as an interval with an upper bound of an upper confidence limit (UCL) and a lower bound of the lower confidence limit (Figure 2). This is because a complete, continuous data set of measured water quality concentrations is not available for any parameter at any location evaluated. An exact singular value representing the true central tendency of the surface water quality can only be calculated when the data set contains an infinite number of data points. While it is impossible to collect an infinite amount of data points, PolyMet did collect an appropriate number of data points (11-296) for each parameter at each location to characterize existing water quality. PolyMet then used this data set to appropriately calculate a value (see Attachment A) that is 95% likely to contain the true central tendency. The MPCA did not consider the lower 95% confidence interval of the true central tendency, because this review is most concerned with the upper range of water quality values that are closer to the water quality standard and the lower 95% UCL is likely to be below the detection limit for most parameters.

Figure 2. Graphical representation of how confidence intervals are used to characterize the true mean with 95% confidence. This figure assumes the observed distribution of data is normally and continuously distributed.



The design model effluent concentrations do not have conventional uncertainty intervals (i.e., X µg/L ± Y%) because the wastewater design model does not have the capacity to estimate such uncertainty intervals. Therefore, the MPCA treated the projected design model effluent concentrations as a realistic estimate of the achievable future effluent concentrations. In contrast, surface water quality at each location was characterized by a range of data points and not by a single data point or value.

When choosing a statistical methodology to compare these two data types (i.e., a single value versus a range of data), conventional statistical tests such as a two-sample t-test are not appropriate and indicators of statistical significance such as P-values cannot be generated. Consequently, the MPCA decided to assess measurable change using the simple analysis of determining whether the design model concentration for any parameter was higher or lower than the 95% UCL of surface water quality.

PolyMet initially chose to calculate average existing water quality using substitution methodologies in its Antidegradation Evaluation; it later submitted, at MPCA's request, a statistical supplement attached to this document (Attachments A & B) with different statistical methodologies. In PolyMet's approach in the Antidegradation Evaluation, if the data set had a measured value less than the detection limit, a value of ½ the detection limit was assigned. Calculating averages using substitution methodologies is not recommended by the creators of the EPA statistical software package used in this analysis (ProUCL Version 5.1 Technical Guide, EPA). The MPCA therefore requested that PolyMet recalculate surface water quality statistics ; PolyMet completed the calculations and submitted that information to the MPCA (Table 2 below; Attachment B of Antidegradation Evaluation). The summarized statistics are attached to this document and were used by the MPCA to define existing water quality; these tables contain different values than the summary statistics in Large Table 2 of Volume V of the NPDES/SDS permit application because of the use of more appropriate statistical methodologies.

In its Antidegradation Evaluation, PolyMet assessed measurable change by characterizing the variability surrounding the average surface water concentration using the variability of the Laboratory Control Samples (LCS) acceptance criteria, not the actual measured water quality variability. The PolyMet approach to determining existing water quality does not consider the measured variability surrounding the average concentrations as shown in Figure 3 below. Therefore, in its review the MPCA chose to use the UCL, as discussed above.

Figure 3 uses total nickel values at SD026/PM-7 to contrast the PolyMet and the MPCA approach to determining existing water quality. In Figure 3, the PolyMet approach uses ½ the detection limit substitution methods to calculate the average nickel value and assumes the variability surrounding that average is +/- 0.2 µg/L, which is the typical LCS range for nickel at that concentration value. The MPCA considered the range of measured values, including the 95% UCL. For example, MPCA assumes the water quality variability is bounded by the 95% UCL (2.8 µg/L) because the existing water quality must take into account the measured natural variability around the central tendency. This is consistent with the definition of "existing water quality" in the antidegradation rule, Minn. R. 7050.0255, subp. 16. MPCA determined that a measurable change would not occur if the projected effluent concentration was within the measured natural variability as defined by the 95% UCL.

Degradation Review

Considering the FEIS concentrations and the evaluation of existing water quality and measurable change provided in PolyMet's Evaluation, 13 parameters would experience degraded water quality at SD026 because of the proposed discharge (Table 2). Considering the more refined design model concentration and the 95% UCL definition of measurable change predicts only four parameters would experience degraded water quality at SD026 (Table 2) and also predicts a smaller extent of degradation for three of the four (Table 3). Using the design model concentrations does not assume degradation where no degradation is likely to occur and better reflects the future performance of the WWTS. Ultimately, both of these approaches reach the same result, which is that degradation of water quality for some parameters will occur and therefore it is necessary to assess whether the proposed Project will meet criteria for any degradation to occur under Minnesota antidegradation requirements.

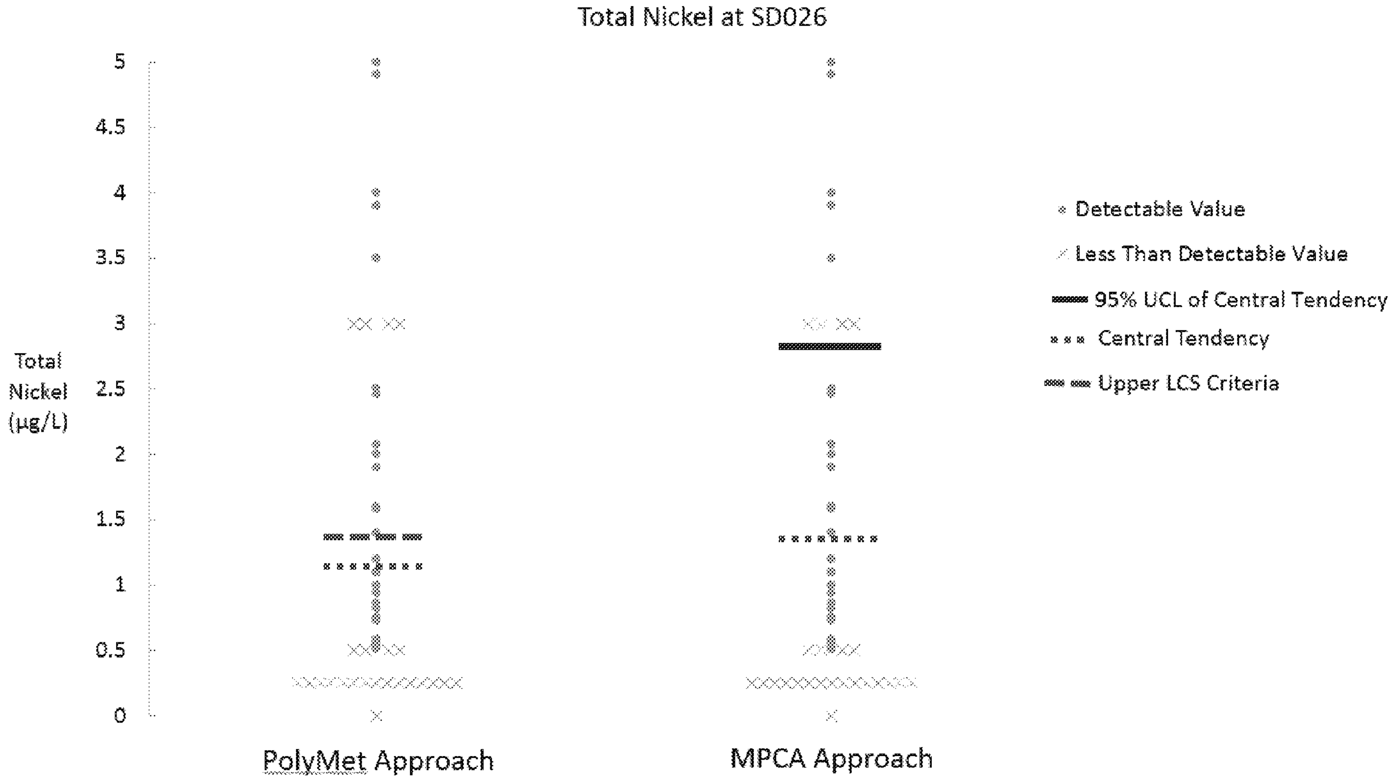
Table 2. Comparison of the results of the MPCA's and PolyMet's approach to assess whether or not the projected discharge will cause degraded water quality. A cell containing "Degradation" indicates degradation will occur and a blank cell indicates no degradation is expected to occur.

	SD026		**TC1-a**		**PM-11**	
	Initial Evaluation Approach	Additional Review Approach	Initial Evaluation Approach	Additional Review Approach	Initial Evaluation Approach	Additional Review Approach
Aluminum (total)						
Antimony (total)	Degradation		Degradation		Degradation	
Arsenic (total)	Degradation		Degradation		Degradation	
Boron (total)			Degradation	Degradation		
Cadmium (total)	Degradation		Degradation		Degradation	
Chromium (total)	Degradation		Degradation		Degradation	
Cobalt (total)	Degradation		Degradation		Degradation	
Copper (total)	Degradation		Degradation	Degradation	Degradation	
Lead (total)	Degradation		Degradation		Degradation	
Nickel (total)	Degradation		Degradation		Degradation	
Selenium (total)	Degradation		Degradation		Degradation	
Silver (total)			Degradation		Degradation	
Thallium (total)		Degradation	Degradation	Degradation	Degradation	
Zinc (total)	Degradation		Degradation		Degradation	
Chloride	Degradation	Degradation	Degradation	Degradation	Degradation	Degradation
Hardness (as $CaCO_3$)						
pH	Degradation	Degradation	Degradation	Degradation	Degradation	Degradation
TDS						
Specific Conductance			Measurable Increase*		Measurable Increase*	
Sulfate						
Mercury (total)	Degradation	Degradation				

1. Degradation (measurable increase) evaluated using LCS acceptance criteria and FEIS effluent concentrations.
2. Degradation (measurable increase) evaluated using 95% UCL and design model effluent concentrations.

*Tier 2 protection of high water quality does not apply to class 4A water quality standards and the antidegradation review only evaluates Tier 1 protection of beneficial and existing uses. This distinction is noted by using the words "Measurable Increase" instead of "Degradation."

Figure 3. Comparison of the PolyMet approach for determining measurable change to the MPCA approach for determining measurable change. The PolyMet approach uses the upper LCS acceptance criteria and the MPCA approach has 95% upper confidence limits associated with the range of sixty measured surface water quality data points. Less than detectable values are shown jittered at their respective measured detection limits.



The MPCA analyzed the measurable change in water quality only with respect to concentrations and did not evaluate measurable change with respect to mass rate loadings. This decision was based on the slight net decrease in water flow rate from the site expected with the project. The NPDES application projected net changes in flow to the Embarrass River and Lower Partridge River of less than two percent. *See* Antidegradation Evaluation, Attachment F, Tables 1 and 2. Because the water flow rate will decrease and mass loading is the product of water flow and water concentration, the only factor that could increase mass loading in this case is changes in concentration. Consequently, change in concentration is a direct surrogate for changes in mass loading and assessing for changes in concentration is also protective for changes in mass loading.

Projected effluent evaluation

Using the data described above, MPCA compared the projected discharge to the 95% UCL for each parameter at each receiving water as well as the central tendency and the maximum value. Tables 3, 4, and 5 below show the results of this evaluation for SD026/PM-7, TC-1a and PM-11 respectively. The MPCA found that according to the design model effluent quality and the FEIS concentrations, all water quality standards would be met. In addition, the design model concentrations are below the applicable downstream drinking water standards.[1] The method of analysis for the MPCA's comparison of the projected discharge to the 95% UCL for each parameter at each receiving water follows the tables.

[1] Lake Superior is downstream of all discharge points and is designated a Class 1B drinking water.

Table 3. Values used to assess whether the proposed discharge would cause a measurable increase in surface water concentrations at SD026/PM-7.

			Effluent		Surface Water (SD026/PM-7)					Measurable Increase Analysis			
Parameter	Units	Typical Reporting Limit	Design Model Effluent Quality	Design Model Effluent Quality Detectable?	Sample Count	Detectable Value Count	Likely Central Tendency	95% UCL of Central Tendency	Max Value	Measurable Increase Possible?	Measurable increase in reference to central tendency?	Measurable increase in reference to 95% UCL?	Measurable increase in reference to max value?
Aluminum (total)	µg/L	2	0.43	Not Detectable	55	25	23.3	63.7	63.7	No	---	---	---
Antimony (total)	µg/L	0.53	0.38	Not Detectable	11	0	< 0.5	< 0.5	< 0.5	No	---	---	---
Arsenic (total)	µg/L	0.5	0.004	Not Detectable	41	19	0.51	0.7	2	No	---	---	---
Boron (total)	µg/L	100	210	Detectable	98	96	211	221	311	Yes	No	No	No
Cadmium (total)	µg/L	0.2	0.056	Not Detectable	27	2	< 0.2	< 0.2	0.097	No	---	---	---
Chromium (total)	µg/L	1	0.31	Not Detectable	20	3	< 1	1.7	1.7	No	---	---	---
Cobalt (total)	µg/L	0.2	0.011	Not Detectable	102	49	0.48	1	1	No	---	---	---
Copper (total)	µg/L	0.5	0.87	Detectable	68	50	0.96	1.04	2.02	Yes	No	No	No
Lead (total)	µg/L	0.5	0.099	Not Detectable	54	2	< 0.5	1	1	No	---	---	---
Nickel (total)	µg/L	0.5	0.14	Not Detectable	60	36	1.11	2.81	5	No	---	---	---
Selenium (total)	µg/L	1	0.046	Not Detectable	31	3	< 1	2	2	No	---	---	---
Silver (total)	µg/L	0.2	0.059	Not Detectable	17	1	< 0.24	1	1	No	---	---	---
Thallium (total)	µg/L	0.005	0.008	Detectable	21	2	< 0.005	< 0.2	0.003	Yes	Yes	Yes	Yes
Zinc (total)	µg/L	6	0.065	Not Detectable	68	25	7.5	16.8	82.5	No	No	No	No
Chloride	mg/L	5	23.4	Detectable	155	155	11.5	12	21.5	Yes	Yes	Yes	Yes
Hardness (as $CaCO_3$)	mg/L	10	59.1	Detectable	220	220	466	479	780	Yes	No	No	No
pH	SU	0.01	8.4	Detectable	296	296	7.8	7.9	8.7	Yes	Yes	Yes	No
TDS	mg/L	10	213	Detectable	155	155	650	669	1540	Yes	No	No	No
Spec	µS/cm	0	334	Detectable	299	299	1005	1024	1393	Yes	No	No	No
Sulfate	mg/L	1	9.84	Detectable	154	153	173	179	360	Yes	No	No	No
Mercury (total)	ng/L	0.5	≤ 1.3*	Detectable	89	47	0.6	0.7	2.1	Yes	Yes**	Yes**	No**

*Mercury concentrations were assumed to be less than or equal to the 1.3 ng/L water quality standard.

**Measurable increase was calculated by assuming that the design model effluent quality was equal to the highest possible effluent concentration of 1.3 ng/L and not the censored value of ≤ 1.3 ng/L.

Table 4. Values used to assess whether the proposed discharge would cause a measurable increase in surface water concentrations at TC-1a.

			Effluent		Surface Water (TC-1a)					Measurable Increase Analysis			
Parameter	Units	Typical Reporting Limit	Design Model Effluent Quality	Effluent Detectable?	Sample Count	Detectable Value Count	Likely Central Tendency	95% UCL of Central Tendency	Max Value	Measurable Increase Possible?	Measurable increase in reference to central tendency?	Measurable increase in reference to 95% UCL?	Measurable increase in reference to max value?
Aluminum (total)	µg/L	2	0.43	Not Detectable	38	28	23.6	26.9	76.4	No	---	---	---
Antimony (total)	µg/L	0.53	0.38	Not Detectable	17	0	< 0.5	< 0.5	< 0.5	No	---	---	---
Arsenic (total)	µg/L	0.5	0.004	Not Detectable	38	20	0.9	1.23	3.7	No	---	---	---
Boron (total)	µg/L	100	210	Detectable	12	11	142	155	185	Yes	Yes	Yes	Yes
Cadmium (total)	µg/L	0.2	0.056	Not Detectable	12	0	< 0.2	< 0.2	< 0.2	No	---	---	---
Chromium (total)	µg/L	1	0.31	Not Detectable	12	0	< 1	< 1	1	No	---	---	---
Cobalt (total)	µg/L	0.2	0.011	Not Detectable	38	18	< 0.2	0.3	0.72	No	---	---	---
Copper (total)	µg/L	0.5	0.87	Detectable	38	17	< 0.5	0.8	3.6	Yes	Yes	Yes	No
Lead (total)	µg/L	0.5	0.099	Not Detectable	38	0	< 0.5	< 0.5	< 0.5	No	---	---	---
Nickel (total)	µg/L	0.5	0.14	Not Detectable	38	10	< 0.5	0.6	1.2	No	---	---	---
Selenium (total)	µg/L	1	0.046	Not Detectable	24	0	< 1	< 1	< 1	No	---	---	---
Silver (total)	µg/L	0.2	0.059	Not Detectable	5	0	< 0.2	< 0.2	< 0.2	No	---	---	---
Thallium (total)	µg/L	0.005	0.008	Detectable	24	0	< 0.005	< 0.02	< 0.02	Yes	Yes	Yes	Yes
Zinc (total)	µg/L	6	0.065	Not Detectable	38	2	< 6	11.5	11.5	No	---	---	---
Chloride	mg/L	5	23.4	Detectable	38	38	17.3	19.5	33.5	Yes	Yes	Yes	No
Hardness (as $CaCO_3$)	mg/L	10	59.1	Detectable	38	38	331	366	547	Yes	No	No	No
pH	SU	0.01	8.4	Detectable	38	38	7.4	7.44	7.82	Yes	Yes	Yes	Yes
TDS	mg/L	10	213	Detectable	38	38	474	511	722	Yes	No	No	No
Spec	µS/cm	0	334	Detectable	38	38	723	795	1150	Yes	No	No	No
Sulfate	mg/L	1	9.84	Detectable	38	36	51	62.19	132	Yes	No	No	No
Mercury (total)	ng/L	0.5	≤ 1.3*	Detectable	12	12	2.13	2.81	5.1	Yes	No	No	No

*Mercury concentrations were assumed to be less than or equal to the 1.3 ng/L water quality standard.

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Table 5. Values used to assess whether the proposed discharge would cause a measurable increase in surface water concentrations at PM-11.

			WWTP Effluent		Surface Water (PM-11)					Measurable Increase Analysis			
Parameter	Units	Typical Reporting Limit	Design Model Effluent Quality	Effluent Detectable?	Sample Count	Detectable Value Count	Likely Central Tendency	95% UCL	Max Value	Measurable Increase Possible?	Measurable increase in reference to central tendency?	Measurable increase in reference to 95% UCL?	Measurable increase in reference to max value?
Aluminum (total)	µg/L	2	0.43	Not Detectable	66	48	29.9	34	119	No	---	---	---
Antimony (total)	µg/L	0.53	0.38	Not Detectable	35	0	< 0.5	< 3	< 3	No	---	---	---
Arsenic (total)	µg/L	0.5	0.004	Not Detectable	58	35	0.92	1	4.1	No	---	---	---
Boron (total)	µg/L	100	210	Detectable	23	22	210	232	307	Yes	No	No	No
Cadmium (total)	µg/L	0.2	0.056	Not Detectable	26	5	< 0.2	< 0.2	0.069	No	---	---	---
Chromium (total)	µg/L	1	0.31	Not Detectable	26	5	< 1	2.3	2.3	No	---	---	---
Cobalt (total)	µg/L	0.2	0.011	Not Detectable	64	17	< 0.2	0.8	7.6	No	---	---	---
Copper (total)	µg/L	0.5	0.87	Detectable	66	53	0.84	0.9	2.3	Yes	Yes	No	No
Lead (total)	µg/L	0.5	0.099	Not Detectable	60	6	< 0.5	< 1	0.15	No	---	---	---
Nickel (total)	µg/L	0.5	0.14	Not Detectable	66	25	0.57	0.7	1.7	No	---	---	---
Selenium (total)	µg/L	1	0.046	Not Detectable	42	3	< 1	< 3.6	0.61	No	---	---	---
Silver (total)	µg/L	0.2	0.059	Not Detectable	21	0	< 0.2	< 1	< 1	No	---	---	---
Thallium (total)	µg/L	0.005	0.008	Detectable	47	5	0.0075	0.0092	0.0092	Yes	Yes	No	No
Zinc (total)	µg/L	6	0.065	Not Detectable	66	7	< 6	41.2	41.2	No	---	---	---
Chloride	mg/L	5	23.4	Detectable	81	81	17	18.6	34.1	Yes	Yes	Yes	No
Hardness (as $CaCO_3$)	mg/L	10	59.1	Detectable	66	66	373	407	705	Yes	No	No	No
pH	SU	0.01	8.4	Detectable	76	76	7.6	7.6	8.3	Yes	Yes	Yes	Yes
TDS	mg/L	10	213	Detectable	66	66	492	532.4	927	Yes	No	No	No
Specific Conductance	µS/cm	0	334	Detectable	70	70	793	848.6	1386	Yes	No	No	No
Sulfate	mg/L	1	9.84	Detectable	85	85	115	145.7	245	Yes	No	No	No
Mercury (total)	ng/L	0.5	≤ 1.3*	Detectable	12	32	1.73	2.1	5.95	Yes	No	No	No

*Mercury concentrations were assumed to be less than or equal to the 1.3 ng/L water quality standard.

Analysis findings

MPCA reviewed the comparison of the projected discharges against the water quality standards above. In all cases, water quality standards would be met in the receiving waters. For all parameters except those below in Table 6, the MPCA projects no degradation from the new discharge (Table 2). MPCA identified the parameters and discharge points expected to be above the 95% UCL of central tendency of measured surface water values. In the cases of pH, mercury, copper, thallium, boron and chloride, where a small measurable increase in water quality would occur, the degradation was minimized. Degradation is allowed only to the extent necessary to accommodate important economic or social changes as described in the following section and in Antidegradation Evaluation Sections 7.4 (pp. 70-77) and 9.3 (pp. 96-99). Tables 6 below provides a summary of the parameters that will experience degraded water quality based on the design model effluent quality.

Table 6. Summary of the expected degradation associated with the project in comparison to the 95% UCL of the central tendency of surface water quality.

Location	Parameter	Degradation Predicted?	Water Quality Standard	95% UCL	Projected Water Quality	Projected Increase	Degradation as a percentage of the Water Quality Standard
PM-11	Chloride	Yes	230	18.6	23.4	4.8 mg/L	1.95%
PM-11	pH	Yes	6 to 9	7.6	8.4	0.8 $\log_{10}$	---
SD026/PM-7	Mercury	Yes	1.3	0.6	≤ 1.3	≤ 0.7 ng/L	≤ 53%
SD026/PM-7	Chloride	Yes	230	12	23.4	11.4 mg/L	4.95%
SD026/PM-7	Thallium	Yes	0.56	< 0.2	0.008	0.008 µg/L	1.42%
SD026/PM-7	pH	Yes	6 to 9	7.9	8.4	0.5 $\log_{10}$	---
TC-1a	Boron	Yes	500	155	210	55 µg/L	11.00%
TC-1a	Chloride	Yes	230	19.5	23.4	3.9 mg/L	1.69%
TC-1a	Thallium	Yes	0.56	< 0.02	0.008	0.008 µg/L	1.42%
TC-1a	pH	Yes	6 to 9	7.9	8.4	0.5 $\log_{10}$	---
TC-1a	Copper	Yes	9.3	0.8	0.87	0.07 µg/L	0.75%

Designated uses in classes other than Class 2 are subject to protection to ensure the maintenance of any existing beneficial use. MPCA found that uses in other use classes will be met by both the FEIS concentrations and the design model concentrations, including the Class 3 hardness standard and the Class 4A sodium, bicarbonate, total dissolved solids, specific conductance and pH water quality standards. See Minn. R. 7050.0223, 7050.0224. The proposed project will cut off movement of existing polluted groundwater. As a result, the headwaters of Second Creek, Trimble Creek and Unnamed Creek will experience an improvement in water quality for sulfate and salty parameters when treated effluent is discharged to those locations.

Bioaccumulative chemicals of concern

The only bioaccumulative chemical of concern in the effluent is mercury. The net loading of mercury will be prudently and feasibly minimized using the best available treatment technologies. The effluent from the wastewater treatment system is expected to be at or below the water quality standard of 1.3 ng/L and will not cause or contribute to any downstream mercury water quality exceedance. The receiving water wetlands and downstream creeks are not listed as impaired for mercury under Section 303(d) of the Clean Water Act; however, observed values in the downstream creeks are periodically in excess of applicable water quality standards (1.3 ng/L), primarily as a result of atmospheric deposition (Section 8.1 (pp. 83-84) of the Antidegradation Evaluation). Existing water quality with respect to mercury is discussed in Section 8.2 (pp. 84-85) of the Antidegradation Evaluation. Section 8.3 (pp. 85-93) of the Antidegradation Evaluation provides a comparison of existing and estimated water quality for mercury due to the project. All downstream waters are expected to show no measurable increase in estimated mercury concentrations or loading as compared to existing conditions. Additionally, because of flow (and resulting mercury loading) reductions to the Partridge River from the project upstream of the confluence with Second Creek, the overall loading of mercury to the Partridge River (and to the St. Louis River) downstream of Second Creek is estimated to decrease from current conditions. Because of the net decrease, all downstream OIRWs and ORVWs, including Lake Superior, will be protected.

Conclusions on existing uses

The Antidegradation Evaluation conducted by PolyMet used the conservatively high effluent concentrations from the FEIS to ensure the Evaluation was protective of all existing water quality standards and designated uses. The PolyMet analysis did not rely on the lower effluent concentrations that resulted from the subsequent engineering design modeling. MPCA considered both sources of data and found all projected effluent concentrations will be below water quality standards according to both the FEIS effects analysis and the projected engineering design modeling. MPCA used different methods to determine measurable changes from existing water quality, but reached the same conclusion as PolyMet's Antidegradation Evaluation. The MPCA does not anticipate the proposed discharge, in combination with any other discharges to the receiving waters, will cause an exceedance of any water quality standard. Because the WWTS effluent will be below water quality standards, the discharge will not cause or contribute to an exceedance of a water quality standard in immediate receiving waters or downstream waters, including waters protected for drinking water use.

A prudent and feasible alternative that minimizes degradation exists and degradation will be minimized

<u>Minn. R. 7050.0265 subp. 5 – Protection of surface waters of high quality.</u>

A. *The commissioner shall not approve a proposed activity when the commissioner makes a finding that prudent and feasible prevention, treatment, or loading offset alternatives exist that would avoid degradation of existing high water quality. When the commissioner finds that prudent and feasible prevention, treatment, or loading offset alternatives are not available to avoid degradation, a proposed activity shall be approved only when the commissioner makes a finding that degradation will be prudently and feasibly minimized.*

The definition of water "of high quality" only applies to Class 2 water quality standards. Minn. R. 7050.0255 subp. 21. The receiving and downstream waters of the project all qualify as "high quality water" for one or more parameters. The MPCA has determined there is no prudent and feasible prevention, treatment, or loading offset alternative available to completely avoid degradation of these waters. The only way the project could eliminate degradation would be to not discharge any water at all. In order to not discharge any water, PolyMet would have to use imprudent and infeasible treatment technologies, such as evaporation and crystallization, which are extremely energy-intensive and would produce large volumes of waste that would need disposal at a landfill. The chosen prudent and feasible treatment alternative minimizes degradation to such an extent that it would be infeasible and imprudent to require more stringent treatment, such as zero water discharge.

The proposed discharge would contain pollutants, but the proposed treatment is a feasible and prudent alternative that will reduce pollutant concentrations more than any other feasible and prudent alternative, resulting in concentrations of most pollutants below detection limits and each pollutants respective water quality standard. As a result, the degradation is minimized. An analysis of alternatives that minimize net increases in loading of all relevant parameters of concern was performed, and an alternative that prudently and feasibly minimizes degradation was identified to manage all the parameters of concern. The parameters of concern are those parameters that have numeric water quality standards in Minn. R. 7050 and Minn. R. 7052 (including whole effluent toxicity standards). A summary of the alternative analysis process is in Sections 7.4 (pp. 70-77) and 9.3 (pp. 96-99) of the Antidegradation Evaluation. PolyMet's antidegradation alternative analysis relies primarily on the alternatives evaluated in the FEIS. The alternatives evaluation conducted during the environmental review process considered a wide range of pollution minimization strategies to reduce project impacts, including those related to the proposed discharge. These strategies include:

- Backfilling all of the highest sulfur (Category 4 and Category 2/3) waste rock into the mined-out East and Central pits, which will then be flooded for subaqueous disposal to minimize the release of contaminants from the waste rock and consequently the loading of contaminants to the WWTS. Previously this material had been proposed for permanent storage in surface stockpiles.
- Replacement of permanent stockpiles of Category 2/3 and Category 4 waste rock with temporary stockpiles that will be removed after the first 11 years of mining. The stockpiles will include engineered liner systems with a compacted low permeability subgrade, a geomembrane barrier layer and an overliner drainage layer to convey any leachate to the mine site wastewater collection system. The design of the liner system, as shown by modeling, will capture leachate generated by the stockpile;
- An enhanced geomembrane cover system for the Category 1 stockpile to replace the previously proposed soil cover. This will minimize long-term water flow through the stockpile resulting in substantial reduction of stockpile seepage volumes to be treated;
- Incorporation of groundwater collection system encompassing the entire low-sulfur Category 1 waste rock pile that will capture greater than 90% of groundwater and surface seepage from the stockpile for subsequent treatment. The original design for the Category 1 stockpile did not include a groundwater/seepage collection system;
- Bentonite addition to the Tailings Basin dams, beaches and pond bottom to reduce infiltration into the tailings and the amount of seepage wastewater generated;
- Incorporation of a seepage capture system at the Tailings Basin which is designed to capture nearly all of the seepage from the basin (from both NorthMet tailings and from existing LTV tailings) for subsequent treatment prior to discharge;

- Pretreatment of Mine Site water to reduce pollutant loadings to the Tailings Basin and to increase the suitability of Tailings Basin water for reuse in the processing circuit; and
- Installation of an advanced state-of-the-art wastewater treatment system that will utilize a combination of nanofiltration and reverse osmosis treatment technologies. This treatment technology treats wastewater to a much higher degree than more conventional chemical precipitation technologies.

The MPCA's review of the Antidegradation Evaluation presented in the NPDES/SDS permit application focused on the proposed discharge from the Plant Site WWTS. For the duration of the first permit cycle, and for at least the proposed active mining period of the project, this will be the only process water discharge to surface waters authorized under this permit. The draft NPDES/SDS permit contains an express prohibition against mine water or process water discharge to surface waters from the Mine Site. During this operational period, process wastewater from the Mine Site (e.g., mine pit dewatering and stockpile seepage collection) will be captured and routed to the Plant Site for pretreatment prior to use in the processing circuit, including storage/disposal in the Plant Site Tailings Basin. As a result, water from the Mine Site will be a component of the water collected by the Tailings Basin seepage capture system, which will then be treated and discharged from the Plant Site WWTS as authorized by the permit.

Because of this incorporation of Mine Site wastewater into the Plant Site water flowsheet, the MPCA considered Mine Site design and alternatives in its review of the Antidegradation Evaluation for the proposed discharge at the Plant Site. MPCA considered the design of Mine Site infrastructure (including stockpile liners and seepage collection systems), waste rock management during mining operations and the degree of pretreatment provided for Mine Site wastewater at the WWTS. The review included an assessment of the design changes and improvements identified above that were incorporated into the proposed project during the FEIS process to avoid or minimize potential impacts.

Collectively, the incorporation of these components into the project design at the Mine Site will minimize the release of pollutants from the Mine Site, which significantly contributes to the minimization of impacts from the proposed WWTS discharge at the Plant Site.

The analysis complies with the alternative analysis process described in Minnesota Rule 7050.0280 subpart 2, and 7052.0320 subparts 2 and 3. The MPCA finds that there are no prudent and feasible alternatives, including pollution prevention or alternative technology, to completely avoid degradation of downstream receiving waters. The MPCA's review focused on an evaluation of PolyMet's selection of a treatment system that avoids and minimizes the potential degradation (considered Best Technology in Process in Treatment, or BTPT, for purposes of bioaccumulative chemicals of concern). The combined water management and wastewater treatment system alternatives analysis described above also complies with the requirements to identify alternatives for bioaccumulative chemicals of concern and BTPT. PolyMet selected the BTPT for its proposed treatment system.

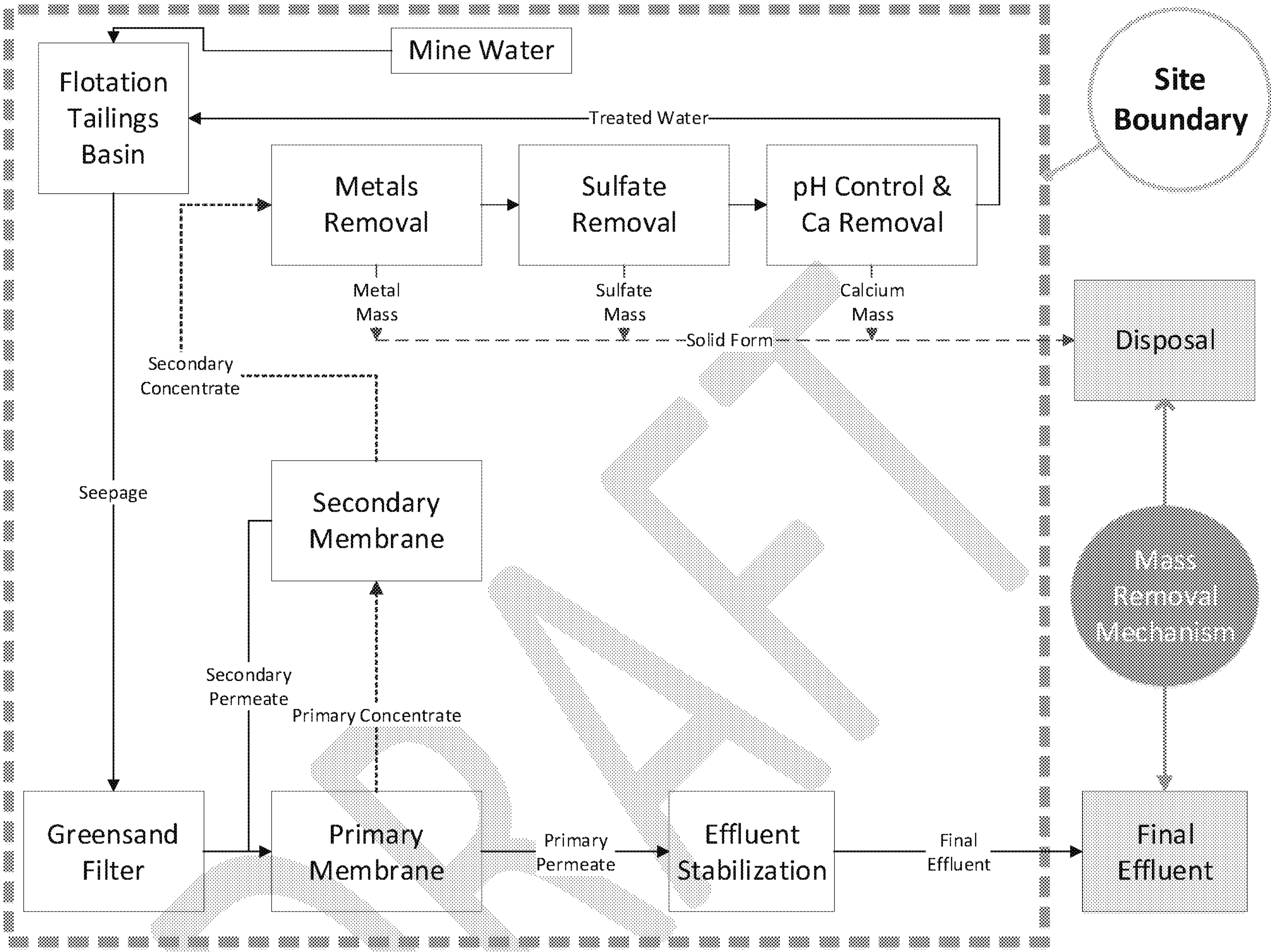
PolyMet has selected a combined water management and wastewater treatment system that will minimize or eliminate pollutant loading to the receiving waters. The selected design utilizes proven technology and has been demonstrated to be effective in project-specific pilot testing. The controlling design criterion is that the combined water management and treatment system consistently achieves a sulfate concentration of 10 mg/L or less in the effluent (Section 3.1.1 on pp. 19-20 of the Antidegradation Evaluation). The degree of treatment necessary to accomplish an effluent concentration of 10 mg/L sulfate will also result in the effective removal of other parameters of concern from the wastewater. So long as sulfate remains at or below 10 mg/L, the proposed treatment system will ensure other parameters are discharged in concentrations similar to the design model concentrations.

Membrane treatment works the same way as a filter, in that a membrane has microscopic holes that allow the water molecules to pass through but retains the targeted constituent on one side of the membrane. A membrane "rejects" molecules – not allowing them to pass through – primarily based on molecular size and ionic charge. As the size and charge of the molecule increase, the membrane tends to reject the molecules to a greater extent. Sulfate is typically rejected across a membrane at >95%, depending on the type of membrane. The rate of sulfate rejection used in modeling was established based on the results of pilot testing at >99% and information from membrane vendors in support of long-term performance. The sulfate rejection rate is comparable to the rejection rate of other parameters of concern, such as heavy metals, because of their size and/or charge. Thus, treating sulfate to low levels (< 10 mg/L) will also treat many other parameters of concern to low levels.

A simplified diagram of the treatment system necessary to achieve less than 10 mg/L sulfate is below in Figure 4. The orange site boundary dashed line represents the physical boundary of the entire proposed site. There are three ways pollutant mass can leave the system: 1) in the effluent in aqueous form 2) for disposal in solid form or 3) as a value-added product in solid form. To minimize pollutant mass in the effluent in aqueous form, it is necessary to convert dissolved pollutant mass into solid form using chemical precipitation. If the WWTS was unable to remove this internal dissolved pollutant mass from the system in solid form, then pollutants would concentrate to unmanageable concentrations. The reason these pollutants would concentrate is because membrane treatment does not remove, eliminate or treat pollutant mass. Membranes only concentrate the pollutant into a smaller volume of water. Ultimately, this smaller volume needs to be treated separately to actually remove pollutant mass using methods such as chemical precipitation.

For this treatment system, primary membrane treatment acts as the final barrier that redirects pollutants (such as sulfate and metals) and prevents them from leaving in the effluent. The primary membrane sends the pollutants to a chemical precipitation treatment chain that removes them from the system. Consequently, the ability of the membrane treatment system to redirect pollutants is essential to the function of the entire treatment system.

Figure 4. Simplified diagram of the proposed WWTS that emphasizes the three ways mass of parameters of concern could leave the system.



The design of the wastewater treatment system, which includes chemical precipitation and membrane treatment, will minimize or eliminate (i.e., to a level below method detection limits in most cases) the concentration of parameters of concern in the effluent. During bench and pilot testing of the membrane treatment system, PolyMet discovered that achieving a sulfate concentration of 10 mg/L or less in the effluent also resulted in the removal of other constituents in the wastewater – such as metals and salty parameters (e.g., calcium, hardness and alkalinity) – to very low levels (Attachment A of the Waste Water Treatment System: Design and Operations Report). In fact, the level of treatment required to achieve a sulfate concentration of 10 mg/L or less in the effluent removes all parameters of concern to such a degree that stabilizing constituents essential for aquatic life, such as calcium and alkalinity, must be added back to the internal waste stream as part of the treatment process to pass Whole Effluent Toxicity (WET) testing requirements. This is a demonstration of how intensive the pollution minimization system is and how the treatment system is designed to ensure that minimal degradation will occur in the receiving waters for all parameters of concern.

The MPCA determined that assessing for degradation in the immediate receiving water addresses degradation in downstream waters. This is because the immediate receiving water has the least amount of flow dilution available and the amount of assimilative capacity available in the receiving water increases as flow increases. Consequently, the magnitude of concentration change from the proposed discharge will decrease as the receiving waters flow farther downstream and flow rate increases. This makes assessing for degradation at the immediate receiving water the most sensitive or protective location to assess degradation for downstream waters. Because the immediate receiving waters would experience minimal degradation and all water quality standards would be met before any dilution, any downstream waters with higher flows would also experience minimal or no degradation.

The project is necessary to accommodate important economic or social development

Minn. R. 7050.0265 subp. 5 – Protection of surface waters of high quality.

B. *The commissioner shall approve a proposed activity only when the commissioner makes a finding that lower water quality resulting from the proposed activity is necessary to accommodate important economic or social changes in the geographic area in which degradation of existing high water quality is anticipated. The commissioner shall consider the following factors in determining the importance of economic or social changes:*

(1) economic gains or losses attributable to the proposed activity, such as changes in the number and types of jobs, median household income, productivity, property values, and recreational, tourism, and other commercial opportunities;

Section 7.5.1 (pp. 78-79) of the Antidegradation Evaluation describes direct and indirect employment that will result from the project, tax generation (federal, state and local), direct value to the State economy in the form of wages and rents, and the direct output value of the extracted minerals. These values are considerable particularly in the context of the relatively depressed economic conditions of the area.

(2) contribution to social services;

Section 7.5.2 (page 79) of the Antidegradation Evaluation describes the local and state tax revenue resulting from the proposed project, which will benefit local social services, local governments and area school systems.

(3) prevention or remediation of environmental or public health threats;

As discussed in Section 7.5.3 (pp. 79) of the Antidegradation Evaluation, construction of the proposed project will remediate an existing water quality issue at the Plant Site, which has not operated for more than 15 years. The project will capture seepage from the former LTVSMC tailings basin that was used in taconite operation, and will provide treatment of that captured tailings basin seepage through an advanced wastewater treatment system resulting in a net reduction of sulfate loading to the Embarrass River watershed of approximately 1600 tons per year, as well as removal of a variety of other constituents. The project is also predicted to result in a small net reduction of mercury loading to the St. Louis River watershed.

(4) trade-offs between environmental media; and

As described in Section 7.5.4 (page 80) of the Antidegradation Evaluation, the proposed project has been designed to minimize any degradation of water quality resulting from the project while at the same time addressing the environmental effects related to water quantity issues. The proposed capture of basin seepage could reduce water quantity in streams and wetlands downgradient of the Tailings Basin. These waters will be augmented with treated wastewater as necessary to maintain existing hydrology. In addition, the location of facility infrastructure such as waste rock stockpiles and mine roads has been designed to minimize impact to wetlands. In general, the proposed treatment will have relatively small impact to other environmental media. Any impacts would primarily be limited to the generation of non-hazardous wastewater treatment residuals (to be disposed of at permitted off-site solid waste facilities and/or the on-site Hydrometallurgical Residue Facility) and air quality effects related to the additional electrical demand for the wastewater treatment system obtained from natural gas and/or coal-fired sources from an off-site power generator.

(5) the value of the water resource, including:

(a) the extent to which the resources adversely impacted by the proposed activity are unique or rare within the locality, state, or nation;

(b) benefits associated with high water quality for uses such as ecosystem services and high water quality preservation for future generations to meet their own needs; and

(c) factors, such as aesthetics, that cannot be reasonably quantified; and

As described in Section 7.5.5 (pp. 80-81) of the Antidegradation Evaluation, the receiving waters and downstream segments of Second Creek, Trimble Creek and Unnamed Creek are not unique or rare locally, within Minnesota or in the United States. With the capture of seepage from the existing ferrous tailings basin, the proposed project is expected to improve the quality of waters downstream from the discharge and benefits associated with high water quality such as ecosystem services should be improved for the future.

(6) other relevant environmental, social, and economic impacts of the proposed activity.

A mineral deposit of this type and size is an uncommon geologic occurrence and the metals in the deposit are needed locally, nationally and globally for a variety of uses. Furthermore, the location of the proposed mineral resource is geologically constrained and cannot be moved elsewhere.

In summary, Section 7.5 (pp. 77-81) of the Antidegradation Evaluation describes the social and economic changes expected from the project as required by rule. Minn. R. 7050.0265; 7052.0320 subp. 2. The social and economic analysis considers economic gains, contributions to social services, prevention or remediation of environmental or public threats, trade-offs between environmental media and the value of the water resources as required in Minn. R. 7050.0265 Subpart 5(b). The social and economic analysis uses the same reasoning and draws the same conclusions as those presented in the FEIS. The analysis appropriately demonstrates that the expected economic and social benefits of the project are important, and the minimal degradation in receiving water quality is necessary to accommodate those benefits.

Protection of restricted outstanding resource value waters

<u>Minn. R. 7050.0265, Subp. 6 - Protection of restricted outstanding resource value waters</u>.

The commissioner shall restrict a proposed activity in order to preserve the existing water quality as necessary to maintain and protect the exceptional characteristics for which the restricted outstanding resource value waters identified under part 7050.0335, subparts 1 and 2, were designated.

The nearest downstream restricted Outstanding Resource Value Water (ORVW) is Lake Superior. As discussed in Sections 7.6 (page 82) and 6.3.6 (page 65) of the Antidegradation Evaluation, a mass balance calculation showed the project will have no measurable effect on water quality in the St. Louis River at Scanlon, prior to the river's entry into Lake Superior. As a result, there would be no measurable effect at Lake Superior. With the selection of the alternative that prudently and feasibly minimizes impacts with respect to facility design and wastewater treatment and the incorporation into the permit of protective limitations, monitoring and other requirements, the proposed activity will be restricted as necessary to preserve the existing water quality to protect Lake Superior.

Protection of prohibited outstanding resource value waters

Minn. R. 7050.0265, Sub. 7 - Protection of prohibited outstanding resource value waters.

The commissioner shall prohibit a proposed activity that results in a net increase in loading or other causes of degradation to prohibited outstanding resource value waters identified under part 7050.0335, subparts 3 and 4.

There are no downstream prohibited ORVWs.

Protection against impairments associated with thermal discharges

Minn. R. 7050.0265, Subp. 8 - Protection against impairments associated with thermal discharges.

When there is potential for water quality impairment associated with thermal discharges, the commissioner's allowance for existing water quality degradation shall be consistent with section 316 of the Clean Water Act, United States Code, title 33, section 1326. When a variance is granted under section 316(a) of the Clean Water Act, United States Code, title 33, section 1326, antidegradation standards under this part still apply.

As discussed in section 7.7 of the Antidegradation Evaluation (page 82), the treatment process will add minimal heat to the water and the discharge will be approximately the same temperature as shallow groundwater. No thermal impacts are expected.

Antidegradation Demonstration for New Discharges in the Lake Superior Basin

Minn. R. 7052.0320 requires an antidegradation demonstration for any discharger proposing a new or expanded discharge of a bioaccumulative substance of immediate concern (BSIC) to an outstanding international resource water (OIRW). PolyMet's proposed discharge of treated wastewater containing mercury (a BSIC) to streams within the St. Louis River watershed meets this criterion. The antidegradation demonstration requires an analysis to identify cost-effective pollution prevention alternatives and treatment techniques that would eliminate or reduce the extent of increased loading of mercury and lowering of water quality. As a discharger proposing a new loading of a BSIC to an OIRW, PolyMet must also provide an analysis of Best Technology in Process and Treatment (BTPT).

PolyMet included an analysis of BTPT in Section 9.3 (pp. 96-99) of the Antidegradation Evaluation. Additional design considerations and constraints, expected performance, and reliability of the least degrading alternative are described in Section 3.0 of the Waste Water Treatment System: Design and Operations Report for the NorthMet project (pp. 13-35). <Link>. Together, these reports provided information on opportunities and technologies the discharger has to minimize the generation of mercury and reduce the loadings in the discharge. The analysis identifies many of the same alternatives and techniques as those described above for non-BSIC pollutants. As identified in the "Existing Uses" section starting on page 8 above, the selection and incorporation of advanced state-of-the-art treatment technology into the project design will minimize the lowering of water quality. The expected performance of the system is based on a combination of engineering design, modeling, redundancy of critical treatment components and physical testing of the systems at the bench and pilot scale. Additional project considerations beyond state-of-the-art treatment include a lower mercury content of NorthMet tailings as compared to existing LTV tailings and the demonstrated mercury filtration capabilities of both NorthMet and LTV tailings. The facility and wastewater treatment system design satisfies the requirements of BTPT in Minn. R. 7052.0320 subp. 3.

Conclusion

Based upon the preliminary review of the information provided in the Antidegradation Evaluation, as well as other reliable information available to the commissioner concerning the proposed activity and other activities that cause cumulative changes in existing water quality in the surface waters, the MPCA has made a preliminary determination that the proposed activity satisfies the standards in Minnesota Rules 7050.0265 and 7052.0300, as well as federal surface water pollution control statutes and rules administered by the commissioner.

References

EPA ProUCL Version 5.1 User Guide. https://www.epa.gov/sites/production/files/2016-05/documents/proucl_5.1_user-guide.pdf

Wastewater Treatment System: Design and Operation Report v2 (wq-wwprm1-41b)
ftp://files.pca.state.mn.us/pub/file_requests/Polymet/wq-wwprm1-51b.pdf

NPDES/SDS Permit Application Vol III – Waste Water Treatment System
https://www.pca.state.mn.us/sites/default/files/wq-wwprm1-50w.pdf

NPDES/SDS Permit Application Vol V – Tailing Basin and Beneficiation Plant

https://www.pca.state.mn.us/sites/default/files/wq-wwprm1-50y.pdf

Antidegradation rulemaking: Attachment 1 to MPCA Post-Hearing Response to Public Comments MPCA Detailed Responses to Public Comments https://www.pca.state.mn.us/sites/default/files/wq-rule3-60j.pdf

Attachment A

This excel document titled:

PolyMet Antideg Measurable Change d4.xlsx

file:///X:\Agency_Files\Water\Standards\Effluent%20Limit%20Review%20Documents\Industrial-Other_TEST\MN0071013%20Polymet\2016\PolyMet%20Antideg%20Measureable%20Change%20d4.xlsx

Attachment B: NorthMet Antidegradation Evaluation Statistical Supplement Methods Summary

MPCA has requested that PolyMet consider statistically evaluating certain datasets with non-detect values using either a nonparametric method (e.g., Kaplan Meier) or a parametric method, when appropriate, rather than using statistical substitution methods. MPCA also requested calculation of the 95% upper confidence limit (UCL) of the mean of baseline data for certain datasets.

In response, PolyMet has evaluated the Antidegradation Evaluation datasets using the ProUCL software, which was developed for the USEPA specifically to analyze datasets that include non-detect values. Table 1 summarizes the methods that PolyMet used in this exercise requested by MPCA to determine a measure of central tendency (an average or an alternate measure for datasets for which there may be limitations affecting calculations of averages). Table 2 summarizes the methods that PolyMet used in this exercise requested by MPCA to determine the 95% UCL. PolyMet used site-specific approaches for datasets with high frequency of non-detects (USEPA 2015, pg. 31).

Table 1 Summary of Non-Substitution Approaches for Measures of Central Tendency

Sample Size	Non-Detect Frequency	Measure of Central Tendency	Citations
All	0%	Arithmetic mean	For datasets with no non-detects, the Kaplan-Meier mean is equal to the arithmetic mean (Helsel 2012)
	≤50%	Kaplan-Meier mean	• Kaplan Meier recommended (USEPA 2009, pg. 15-3) *"The guidance generally favors the use of the ...Kaplan-Meier or Robust ROS* [regression on order statistics] *methods which can address the problem of multiple detection limits"* • Robust ROS ruled out (USEPA 2009, p 8-24) Robust ROS underlying assumptions: *"Data must be normal or normalized..."* • Limit at 50% non-detects (USEPA 2009, pg 8-23) *"Kaplan-Meier should not be used when more than 50% of the data are non-detects."*
	>51%	Median value. If median is a non-detect, report as a less-than value[1]	• Site-specific method (USEPA 2015, sec. 1.12): *"For data sets with low detection frequencies, other measures such as the median or mode represent better estimates (with lesser uncertainty) of the population measure of central tendency."*

[1] For mass balance calculations, when the central tendency of the baseline data was a non-detect value, PolyMet used the median detection limit as the baseline concentration to which Project loading was added.

(USEPA 2009) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance. EPA 530/R-09-007. March 2009.

(USEPA 2015) ProUCL Version 5.1.002 Technical Guide: Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. EPA/600/R-07/041. October 2015.

(Helsel 2012) Statistics for Censored Environmental Data Using Minitab and R 2nd Ed. John Wiley & Sons, Inc., Hoboken, NJ.

Table 2 Summary of Approaches for Calculation of 95% UCLs

Sample Size	Non-Detect Frequency	95% UCL Method	Citation for recommended 95% UCL approach
All	<100%	ProUCL recommended 95% UCL, or highest detected value(1) if: 1) ProUCL program indicates that there are too few detects to calculate a 95%UCL; or, 2) the recommended UCL is less than the median	• Basic approach (USEPA 2015, Sec 1.10) *"ProUCL computes 95% UCLs of the mean using several methods based upon normal, gamma, lognormal, and non-discernible distributions."* • Description of how ProUCL evaluates dataset and recommends a UCL method (USEPA 2015, Sec. 4.6) • Use of highest detected value when there are too few detects to calculate a UCL (USEPA 2015, Sec.1.10.) *"Some practitioners use the maximum detected value as an estimate of the EPC term... when the sample size is small or when a UCL95 exceeds the maximum detected value."*
	100%	Maximum reporting limit	• Approach if 100% non-detects (USEPA 2015; Sec. 1.12): *"...when all of the sampled values are reported as NDs, the [UCL] and other statistical limits should also be reported as a ND* [non-detect] *value, perhaps by the maximum RL* [reporting limit] *or the maximum RL/2. The project team will need to make this determination"*

(1) Highest non-detect value used if highest detect value is less than median.

(USEPA 2015) ProUCL Version 5.1.002 Technical Guide: Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. EPA/600/R-07/041. October 2015.

Other reference materials reviewed for this analysis included the following:

- ITRC, 2013. ITRC Guidance Document: Groundwater Statistics and Monitoring Compliance.
- USEPA, 2006. Data Quality Assessment: Statistical Methods for Practitioners. EPA QA/G-9S; EPA/240/B-06/003. February, 2006.
- USEPA, 2006. On the Computation of a 95% Upper Confidence Limit of the Unknown Population Mean Based Upon Data Sets with Below Detection Limit Observations. EPA/600/R-06/022. Singh, Maichle, and Lee. March, 2006.

ProUCL Results
Baseline Water Quality at Antidegradation Evaluation Monitoring Locations

																	Selected Central Tendency				Selected UCL		
											All data, nd @ DL												
Location	Parameter	Units	n	detects	nd	% ND	min ND	max ND	KM mean	min D	max D	Arith Mean	Median	Raw UCL	Description	Distribution	Flag	Value	Value Adj Units(ug/L)	Method	Value	Value Adj Units (ug/L)	Method
	Aluminum, total	mg/L	10	10	0	0%	N/A	N/A	1.05E-01	0.0293	0.171	1.05E-01	0.12	1.36E-01	95% Student's-t UCL	Normal		1.05E-01	105	Arith Mean	1.36E-01	1.36E+02	95% UCL
	Antimony, total	mg/L	7	6	1	14%	0.0005	0.0005	9.07E-05	0.00005	0.00011	1.49E-04	0.000099	1.09E-04	95% KM (t) UCL	Normal		9.07E-05	0.09	KM Mean	1.09E-04	1.09E-01	95% UCL
	Arsenic, total	mg/L	10	7	3	30%	0.002	0.002	9.91E-04	0.00066	0.0017	1.29E-03	0.0011	1.24E-03	95% KM (t) UCL	Normal		9.91E-04	0.99	KM Mean	1.24E-03	1.24E+00	95% UCL
	Boron, total	mg/L	8	8	0	0%	N/A	N/A	1.01E-01	0.0594	0.15	1.01E-01	0.1003	1.22E-01	95% Student's-t UCL	Normal		1.01E-01	101	Arith Mean	1.22E-01	1.22E+02	95% UCL
	Cadmium, total	mg/L	8	1	7	88%	0.0002	0.0002	3.20E-05	0.000032	0.000032	1.79E-04	0.0002	N/A	Insufficient detects for UCL	N/A	<	2.00E-04	0.20	Median	2.00E-04	2.00E-01	Max ND
	Chromium, total	mg/L	8	5	3	38%	0.001	0.001	5.84E-04	0.00038	0.00095	7.40E-04	0.000775	N/A	Insufficient detects for UCL	N/A		5.84E-04	0.58	KM Mean	9.50E-04	9.50E-01	Max D
	Cobalt, total	mg/L	8	8	0	0%	N/A	N/A	4.59E-04	0.00028	0.00073	4.59E-04	0.000445	5.49E-04	95% Student's-t UCL	Normal		4.59E-04	0.46	Arith Mean	5.49E-04	5.49E-01	95% UCL
	Copper, total	mg/L	8	8	0	0%	N/A	N/A	3.35E-03	0.0019	0.0048	3.35E-03	0.0034	4.01E-03	95% Student's-t UCL	Normal		3.35E-03	3.35	Arith Mean	4.01E-03	4.01E+00	95% UCL
	Lead, total	mg/L	8	6	2	25%	0.0005	0.0006	2.72E-04	0.000054	0.00046	3.42E-04	0.00041	4.08E-04	95% KM (t) UCL	Normal		2.72E-04	0.27	KM Mean	4.08E-04	4.08E-01	95% UCL
	Nickel, total	mg/L	8	8	0	0%	N/A	N/A	3.63E-03	0.0027	0.0046	3.63E-03	0.00355	4.00E-03	95% Student's-t UCL	Normal		3.63E-03	3.63	Arith Mean	4.00E-03	4.00E+00	95% UCL
MNSW12 / USGS 04016000	Selenium, total	mg/L	8	7	1	13%	0.001	0.001	5.74E-04	0.00033	0.00099	6.28E-04	0.00057	7.26E-04	95% KM (t) UCL	Normal		5.74E-04	0.57	KM Mean	7.26E-04	7.26E-01	95% UCL
	Silver, total	mg/L	8	4	4	50%	0.0002	0.0002	6.38E-06	0.0000058	0.0000074	1.03E-04	0.0001037	N/A	Insufficient detects for UCL	N/A		6.38E-06	0.01	KM Mean	7.40E-06	7.40E-03	Max D
	Thallium, total	mg/L	7	0	7	100%	0.0004	0.0004	N/A	N/A	N/A	4.00E-04	0.0004	N/A	Insufficient detects for UCL	N/A	<	4.00E-04	0.40	Median	4.00E-04	4.00E-01	Max ND
	Zinc, total	mg/L	16	16	0	0%	N/A	N/A	4.16E-03	0.001	0.0085	4.16E-03	0.0039	4.97E-03	95% Student's-t UCL	Normal		4.16E-03	4.16	Arith Mean	4.97E-03	4.97E+00	95% UCL
	Chloride	mg/L	19	19	0	0%	N/A	N/A	4.91E+00	2.66	8.24	4.91E+00	4.3	5.68E+00	95% Student's-t UCL	Nonparametric		4.91E+00		Arith Mean	5.68E+00		95% UCL
	Hardness, as CaCO3	mg/L	10	10	0	0%	N/A	N/A	2.91E+02	82.5	546	2.91E+02	236	3.88E+02	95% Student's-t UCL	Normal		2.91E+02		Arith Mean	3.88E+02		95% UCL
	pH	S.U.	11	11	0	0%	N/A	N/A	7.61E+00	7.29	7.88	7.61E+00	7.62	7.71E+00	95% Student's-t UCL	Normal		7.61E+00		Arith Mean	7.71E+00		95% UCL
	Solids, total dissolved	mg/L	10	10	0	0%	N/A	N/A	3.75E+02	137	650	3.75E+02	300	4.90E+02	95% Student's-t UCL	Normal		3.75E+02		Arith Mean	4.90E+02		95% UCL
	Specific Conductance @ 25	uS/cm	11	11	0	0%	N/A	N/A	5.99E+02	189	1173	7.93E+02	824.3	7.92E+02	95% Student's-t UCL	Normal		7.93E+02		Arith Mean	1.17E+03		Max D
	Sulfate, as SO4	mg/L	10	10	0	0%	N/A	N/A	1.64E+02	43	302	1.64E+02	127.5	2.24E+02	95% Student's-t UCL	Normal		1.64E+02		Arith Mean	2.24E+02		95% UCL
	Mercury, total	ng/L	3	3	0	0%	N/A	N/A	4.67E+00	2.2	9.5	4.67E+00	2.3	N/A	Insufficient detects for UCL	N/A		4.67E+00		Arith Mean	9.50E+00		Max D
	Aluminum, total	mg/L	12	12	0	0%	N/A	N/A	5.98E-02	0.0264	0.187	5.98E-02	0.04965	1.13E-01	95% Chebyshev(Mean, Sd) UCL	Nonparametric		5.98E-02	5.98E+01	Arith Mean	1.13E-01	1.13E+02	95% UCL
	Antimony, total	mg/L	8	7	1	13%	0.0005	0.0005	6.36E-05	0.00004	0.0001	1.18E-04	0.0000715	8.04E-05	95% KM (t) UCL	Normal		6.36E-05	6.36E-02	KM Mean	8.04E-05	8.04E-02	95% UCL
	Arsenic, total	mg/L	12	7	5	42%	0.002	0.002	1.64E-03	0.0011	0.0029	1.90E-03	0.002	1.97E-03	95% KM (t) UCL	Normal		1.64E-03	1.64E+00	KM Mean	1.97E-03	1.97E+00	95% UCL
	Boron, total	mg/L	8	8	0	0%	N/A	N/A	8.50E-02	0.0536	0.113	8.50E-02	0.0896	9.95E-02	95% Student's-t UCL	Normal		8.50E-02	8.50E+01	Arith Mean	9.95E-02	9.95E+01	95% UCL
	Cadmium, total	mg/L	8	2	6	75%	0.0002	0.0002	4.30E-05	0.000042	0.000044	1.61E-04	0.0002	N/A	Insufficient detects for UCL	N/A	<	2.00E-04	2.00E-01	Median	2.00E-04	2.00E-01	Max ND
	Chromium, total	mg/L	8	6	2	25%	0.001	0.001	5.72E-04	0.00033	0.0012	7.01E-04	0.000635	7.90E-04	95% KM (t) UCL	Normal		5.72E-04	5.72E-01	KM Mean	7.90E-04	7.90E-01	95% UCL
	Cobalt, total	mg/L	8	8	0	0%	N/A	N/A	7.71E-04	0.00063	0.0011	7.71E-04	0.000715	8.81E-04	95% Student's-t UCL	Normal		7.71E-04	7.71E-01	Arith Mean	8.81E-04	8.81E-01	95% UCL
	Copper, total	mg/L	8	6	2	25%	0.0007	0.0007	7.75E-04	0.00067	0.0014	7.80E-04	0.000695	9.49E-04	95% KM (t) UCL	Nonparametric		7.75E-04	7.75E-01	KM Mean	9.49E-04	9.49E-01	95% UCL
	Lead, total	mg/L	8	5	3	38%	0.0005	0.0006	2.30E-04	0.000079	0.00094	3.94E-04	0.000345	N/A	Insufficient detects for UCL	N/A		2.30E-04	2.30E-01	KM Mean	9.40E-04	9.40E-01	Max D
	Nickel, total	mg/L	8	8	0	0%	N/A	N/A	5.73E-03	0.0037	0.0078	5.73E-03	0.0056	6.73E-03	95% Student's-t UCL	Normal		5.73E-03	5.73E+00	Arith Mean	6.73E-03	6.73E+00	95% UCL
MNSW8	Selenium, total	mg/L	8	7	1	13%	0.001	0.001	7.74E-04	0.00043	0.0012	8.18E-04	0.0008	9.65E-04	95% KM (t) UCL	Normal		7.74E-04	7.74E-01	KM Mean	9.65E-04	9.65E-01	95% UCL
	Silver, total	mg/L	8	5	3	38%	0.0002	0.0002	8.32E-06	0.0000058	0.000012	8.02E-05	0.000011	N/A	Insufficient detects for UCL	N/A		8.32E-06	8.32E-03	KM Mean	1.20E-05	1.20E-02	Max D
	Thallium, total	mg/L	8	0	8	100%	0.0004	0.0004	N/A	N/A	N/A	4.00E-04	0.0004	N/A	Insufficient detects for UCL	N/A	<	4.00E-04	4.00E-01	Median	4.00E-04	4.00E-01	Max ND
	Zinc, total	mg/L	16	15	1	6%	0.006	0.006	4.20E-03	0.00082	0.0078	4.36E-03	0.0044	5.08E-03	95% KM (t) UCL	Normal		4.20E-03	4.20E+00	KM Mean	5.08E-03	5.08E+00	95% UCL
	Chloride	mg/L	23	23	0	0%	N/A	N/A	8.45E+00	7.27	10.6	8.45E+00	8.4	8.76E+00	95% Student's-t UCL	Normal		8.45E+00		Arith Mean	8.76E+00		95% UCL
	Hardness, as CaCO3	mg/L	12	12	0	0%	N/A	N/A	8.06E+02	491	949	8.06E+02	883.5	8.87E+02	95% Student's-t UCL	Nonparametric		8.06E+02		Arith Mean	8.87E+02		95% UCL
	pH	S.U.	13	13	0	0%	N/A	N/A	7.76E+00	7.37	8.03	7.75E+00	7.8	7.84E+00	95% Student's-t UCL	Normal		7.75E+00		Arith Mean	7.84E+00		95% UCL
	Solids, total dissolved	mg/L	12	12	0	0%	N/A	N/A	9.49E+02	549	1260	9.49E+02	999.5	1.06E+03	95% Student's-t UCL	Normal		9.49E+02		Arith Mean	1.06E+03		95% UCL
	Specific Conductance @ 25	uS/cm	13	13	0	0%	N/A	N/A	1.32E+03	856.3	1665	1.32E+03	1409	1.44E+03	95% Student's-t UCL	Normal		1.32E+03		Arith Mean	1.44E+03		95% UCL
	Sulfate, as SO4	mg/L	12	12	0	0%	N/A	N/A	4.73E+02	269	624	4.73E+02	507	5.29E+02	95% Student's-t UCL	Normal		4.73E+02		Arith Mean	5.29E+02		95% UCL
	Mercury, total	ng/L	7	7	0	0%	N/A	N/A	4.03E+00	1.4	7.5	4.03E+00	3.9	5.64E+00	95% Student's-t UCL	Normal		4.03E+00		Arith Mean	5.64E+00		95% UCL
	Aluminum, total	mg/L	66	48	18	27%	0.01	0.04	2.99E-02	0.0104	0.119	3.26E-02	0.0283	3.40E-02	95% KM (t) UCL	Nonparametric		2.99E-02	2.99E+01	KM Mean	3.40E-02	3.40E+01	95% UCL
	Antimony, total	mg/L	35	0	35	100%	0.0005	0.003	N/A	N/A	N/A	7.86E-04	0.0005	N/A	Insufficient detects for UCL	N/A	<	5.00E-04	5.00E-01	Median	3.00E-03	3.00E+00	Max ND
	Arsenic, total	mg/L	58	35	23	40%	0.0005	0.002	9.24E-04	0.00051	0.0041	1.03E-03	0.000795	1.03E-03	95% KM H-UCL	Lognormal		9.24E-04	9.24E-01	KM Mean	1.03E-03	1.03E+00	95% UCL
	Boron, total	mg/L	23	22	1	4%	0.1	0.1	2.10E-01	0.109	0.307	2.10E-01	0.228	2.32E-01	95% KM (t) UCL	Normal		2.10E-01	2.10E+02	KM Mean	2.32E-01	2.32E+02	95% UCL
	Cadmium, total	mg/L	26	5	21	81%	0.00003	0.0002	3.35E-05	0.000021	0.000069	1.62E-04	0.0002	N/A	Insufficient detects for UCL	N/A	<	2.00E-04	2.00E-01	Median	2.00E-04	2.00E-01	Max ND
	Chromium, total	mg/L	26	5	21	81%	0.001	0.001	5.98E-04	0.00033	0.0023	1.04E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	2.30E-03	2.30E+00	Max D
	Cobalt, total	mg/L	64	17	47	73%	0.0002	0.001	3.13E-04	0.00016	0.0076	4.16E-04	0.0002	8.31E-04	95% KM (Chebyshev) UCL	Nonparametric	<	2.00E-04	2.00E-01	Median	8.31E-04	8.31E-01	95% UCL
	Copper, total	mg/L	66	53	13	20%	0.0005	0.005	8.43E-04	0.0005	0.0023	1.07E-03	0.000795	9.21E-04	95% KM Adjusted Gamma UCL	Gamma		8.43E-04	8.43E-01	KM Mean	9.21E-04	9.21E-01	95% UCL
	Lead, total	mg/L	60	6	54	90%	0.0003	0.001	7.87E-05	0.00003	0.00015	4.80E-04	0.0005	1.11E-04	95% KM (t) UCL	Normal	<	5.00E-04	5.00E-01	Median	1.00E-03	1.00E+00	Max ND
	Nickel, total	mg/L	66	25	41	62%	0.0005	0.005	6.78E-04	0.00054	0.0017	9.50E-04	0.00057	7.44E-04	95% KM (t) UCL	Normal		5.70E-04	5.70E-01	Median	7.44E-04	7.44E-01	95% UCL
PM-11	Selenium, total	mg/L	42	3	39	93%	0.001	0.0036	4.53E-04	0.00024	0.00061	1.30E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	3.60E-03	3.60E+00	Max ND
	Silver, total	mg/L	21	0	21	100%	0.0002	0.001	N/A	N/A	N/A	3.60E-04	0.0002	N/A	Insufficient detects for UCL	N/A	<	2.00E-04	2.00E-01	Median	1.00E-03	1.00E+00	Max ND
	Thallium, total	mg/L	47	5	42	89%	0.0000004	0.002	1.60E-06	0.0000013	0.0000092	2.31E-04	0.0000075	N/A	Insufficient detects for UCL	N/A		7.50E-06	7.50E-03	Median	9.20E-06	9.20E-03	Max D
	Zinc, total	mg/L	66	7	59	89%	0.006	0.01	3.36E-03	0.0016	0.0412	7.01E-03	0.006	4.62E-03	95% KM (t) UCL	Normal	<	6.00E-03	6.00E+00	Median	4.12E-02	4.12E+01	Max D
	Chloride	mg/L	81	81	0	0%	N/A	N/A	1.70E+01	3.1	34.1	1.70E+01	16.5	1.86E+01	95% Student's-t UCL	Normal		1.70E+01		Arith Mean	1.86E+01		95% UCL
	Hardness, as CaCO3	mg/L	66	66	0	0%	N/A	N/A	3.73E+02	109	705	3.73E+02	349.5	4.07E+02	95% Student's-t UCL	Normal		3.73E+02		Arith Mean	4.07E+02		95% UCL
	pH	S.U.	76	76	0	0%	N/A	N/A	7.56E+00	6.64	8.3	7.56E+00	7.615	7.62E+00	95% Student's-t UCL	Normal		7.56E+00		Arith Mean	7.62E+00		95% UCL
	Solids, total dissolved	mg/L	66	66	0	0%	N/A	N/A	4.92E+02	186	927	4.92E+02	458.5	5.32E+02	95% Student's-t UCL	Normal		4.92E+02		Arith Mean	5.32E+02		95% UCL
	Specific Conductance @ 25	uS/cm	70	70	0	0%	N/A	N/A	7.93E+02	248	1386	7.93E+02	824.3	8.49E+02	95% Student's-t UCL	Normal		7.93E+02		Arith Mean	8.49E+02		95% UCL
	Sulfate, as SO4	mg/L	85	85	0	0%	N/A	N/A	1.15E+02	4.4	245	1.15E+02	106	1.46E+02	95% Chebyshev (Mean, Sd) UCL	Nonparametric		1.15E+02		Arith Mean	1.46E+02		95% UCL
	Mercury, total	ng/L	38	32	6	16%	0.5	10	1.73E+00	0.6	5.95	2.51E+00	1.6	2.10E+00	95% KM Adjusted Gamma UCL	Gamma		1.73E+00		KM Mean	2.10E+00		95% UCL
	Aluminum, total	mg/L	64	64	0	0%	N/A	N/A	1.81E-01	0.0439	0.72	1.81E-01	0.1305	2.52E-01	95% Chebyshev(Mean, Sd) UCL	Nonparametric		1.81E-01	1.81E+02	Arith Mean	2.52E-01	2.52E+02	95% UCL

	Antimony, total	mg/L	26	0	26	100%	0.0005	0.003	N/A	N/A	N/A	8.85E-04	0.0005	N/A	Insufficient detects for UCL	N/A	<	5.00E-04	5.00E-01	Median	3.00E-03	3.00E+00	Max ND
	Arsenic, total	mg/L	47	35	12	26%	0.0005	0.002	1.09E-03	0.00039	0.0025	1.19E-03	0.0011	1.27E-03	95% KM Adjusted Gamma UCL	Gamma		1.09E-03	1.09E+00	KM Mean	1.27E-03	1.27E+00	95% UCL
	Boron, total	mg/L	18	3	15	83%	0.035	0.1	4.47E-02	0.0449	0.0689	7.19E-02	0.05945	N/A	Insufficient detects for UCL	N/A		5.95E-02	5.95E+01	Median	6.89E-02	6.89E+01	Max D
	Cadmium, total	mg/L	21	2	19	90%	0.0002	0.0002	5.43E-05	0.000044	0.00026	1.95E-04	0.0002	N/A	Insufficient detects for UCL	N/A	<	2.00E-04	2.00E-01	Median	2.60E-04	2.60E-01	Max D
	Chromium, total	mg/L	21	5	16	76%	0.001	0.001	1.01E-03	0.00071	0.0043	1.18E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	4.30E-03	4.30E+00	Max D
	Cobalt, total	mg/L	68	42	26	38%	0.0002	0.001	4.12E-04	0.00021	0.0011	6.05E-04	0.00049	4.55E-04	95% KM Adjusted Gamma UCL	Gamma		4.12E-04	4.12E-01	KM Mean	4.55E-04	4.55E-01	95% UCL
	Copper, total	mg/L	70	66	4	6%	0.0007	0.005	1.24E-03	0.00062	0.0023	1.41E-03	0.0012	1.31E-03	95% KM Adjusted Gamma UCL	Gamma		1.24E-03	1.24E+00	KM Mean	1.31E-03	1.31E+00	95% UCL
	Lead, total	mg/L	54	3	51	94%	0.0003	0.001	1.94E-04	0.00015	0.00063	5.20E-04	0.0005	N/A	Insufficient detects for UCL	N/A	<	5.00E-04	5.00E-01	Median	6.30E-04	6.30E-01	Max D
	Nickel, total	mg/L	70	60	10	14%	0.0005	0.005	1.38E-03	0.00054	0.0027	1.59E-03	0.0014	1.50E-03	95% KM (t) UCL	Normal		1.38E-03	1.38E+00	KM Mean	1.50E-03	1.50E+00	95% UCL
PM-13	Selenium, total	mg/L	38	0	38	100%	0.001	0.0036	N/A	N/A	N/A	1.38E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	3.60E-03	3.60E+00	Max ND
	Silver, total	mg/L	16	0	16	100%	0.0002	0.001	N/A	N/A	N/A	4.10E-04	0.00022	N/A	Insufficient detects for UCL	N/A	<	2.20E-04	2.20E-01	Median	1.00E-03	1.00E+00	Max ND
	Thallium, total	mg/L	38	8	30	79%	0.0000004	0.002	3.29E-06	0.0000026	0.000019	2.68E-04	0.000005	5.14E-06	95% KM (t) UCL	Normal	<	5.00E-06	5.00E-03	Median	5.14E-06	5.14E-03	95% UCL
	Zinc, total	mg/L	98	11	87	89%	0.006	0.025	5.15E-03	0.0032	0.061	1.05E-02	0.006	4.98E-03	95% KM H-UCL	Lognormal	<	6.00E-03	6.00E+00	Median	6.10E-02	6.10E+01	Max D
	Chloride	mg/L	83	83	0	0%	N/A	N/A	6.98E+00	2	94.8	6.98E+00	5.08	1.19E+01	95% Chebyshev(Mean, Sd) UCL	Nonparametric		6.98E+00		Arith Mean	1.19E+01		95% UCL
	Hardness, as CaCO3	mg/L	68	68	0	0%	N/A	N/A	1.39E+02	35.6	337	1.39E+02	118	1.56E+02	95% Approximate Gamma UCL	Gamma		1.39E+02		Arith Mean	1.56E+02		95% UCL
	pH	S.U.	71	71	0	0%	N/A	N/A	7.38E+00	6.3	8.6	7.38E+00	7.33	7.47E+00	95% Student's-t UCL	Normal		7.38E+00		Arith Mean	7.47E+00		95% UCL
	Solids, total dissolved	mg/L	68	68	0	0%	N/A	N/A	2.27E+02	48	494	2.27E+02	210.5	2.48E+02	95% Approximate Gamma UCL	Gamma		2.27E+02		Arith Mean	2.48E+02		95% UCL
	Specific Conductance @ 25	uS/cm	71	71	0	0%	N/A	N/A	2.84E+02	42	698.2	2.84E+02	236.5	3.17E+02	95% Approximate Gamma UCL	Gamma		2.84E+02		Arith Mean	3.17E+02		95% UCL
	Sulfate, as SO4	mg/L	87	87	0	0%	N/A	N/A	5.14E+01	7.56	688	5.14E+01	28	8.85E+01	95% Chebyshev (Mean, Sd) UCL	Nonparametric		5.14E+01		Arith Mean	8.85E+01		95% UCL
	Mercury, total	ng/L	43	31	12	28%	2	10	3.43E+00	0.84	12.4	4.30E+00	3.6	4.18E+00	95% KM (t) UCL	Normal		3.43E+00		KM Mean	4.18E+00		95% UCL
	Aluminum, dissolved	mg/L	50	49	1	2%	0.01	0.01	1.01E-01	0.01	1	1.01E-01	0.05	2.09E-01	95% KM (Chebyshev) UCL	Nonparametric		1.01E-01	1.01E+02	KM Mean	2.09E-01	2.09E+02	95% UCL
	Antimony, total	mg/L	0																				
	Arsenic, dissolved	mg/L	67	44	23	34%	0.001	0.001	1.64E-03	0.001	0.02	1.64E-03	0.001	2.92E-03	95% KM (Chebyshev) UCL	Nonparametric		1.64E-03	1.64E+00	KM Mean	2.92E-03	2.92E+00	95% UCL
	Boron, dissolved	mg/L	91	91	0	0%	N/A	N/A	1.11E-01	0.01	0.28	1.11E-01	0.1	1.26E-01	95% Approximate Gamma UCL	Gamma		1.11E-01	1.11E+02	Arith Mean	1.26E-01	1.26E+02	95% UCL
	Cadmium, dissolved	mg/L	48	9	39	81%	0.001	0.002	1.71E-03	0.001	0.02	1.83E-03	0.001	1.67E-03	95% KM H-UCL	Lognormal	<	1.00E-03	1.00E+00	Median	1.67E-03	1.67E+00	95% UCL
	Chromium, dissolved	mg/L	50	26	24	48%	0.001	0.02	6.26E-03	0.001	0.02	7.24E-03	0.001	1.08E-02	95% KM (Chebyshev) UCL	Nonparametric		6.26E-03	6.26E+00	KM Mean	1.08E-02	1.08E+01	95% UCL
	Cobalt, dissolved	mg/L	52	2	50	96%	0.001	0.003	1.12E-03	0.003	0.005	2.83E-03	0.003	N/A	Insufficient detects for UCL	N/A	<	3.00E-03	3.00E+00	Median	5.00E-03	5.00E+00	Max D
	Copper, dissolved	mg/L	33	27	6	18%	0.001	0.02	7.44E-03	0.001	0.11	8.24E-03	0.003	2.20E-02	95% KM (Chebyshev) UCL	Nonparametric		7.44E-03	7.44E+00	KM Mean	2.20E-02	2.20E+01	95% UCL
	Lead, dissolved	mg/L	34	7	27	79%	0.001	0.01	1.40E-03	0.001	0.004	3.12E-03	0.002	1.77E-03	95% KM (t) UCL	Normal	<	2.00E-03	2.00E+00	Median	4.00E-03	4.00E+00	Max D
	Nickel, dissolved	mg/L	39	17	22	56%	0.001	0.01	1.32E-03	0.001	0.005	1.54E-03	0.001	1.52E-03	95% KM (t) UCL	Nonparametric	<	1.00E-03	1.00E+00	Median	1.52E-03	1.52E+00	95% UCL
USGS 04024000	Selenium, dissolved	mg/L	73	3	70	96%	0.001	0.001	1.48E-03	0.001	0.02	1.48E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	2.00E-02	2.00E+01	Max D
	Silver, dissolved	mg/L	53	1	52	98%	0.001	0.002	1.00E-03	0.001	0.001	1.02E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	1.00E-03	1.00E+00	Max D
	Thallium, total	mg/L	0																				
	Zinc, dissolved	mg/L	55	45	10	18%	0.003	0.02	1.88E-02	0.005	0.11	2.02E-02	0.017	3.00E-02	95% KM (Chebyshev) UCL	Nonparametric		1.88E-02	1.88E+01	KM Mean	3.00E-02	3.00E+01	95% UCL
	Chloride	mg/L	387	386	1	0%	0.2	0.2	8.15E+00	0.1	32	8.15E+00	6.8	9.33E+00	95% KM (Chebyshev) UCL	Nonparametric		8.15E+00		KM Mean	9.33E+00		95% UCL
	Hardness, as CaCO3	mg/L	267	267	0	0%	N/A	N/A	7.67E+01	8	190	7.67E+01	73	7.88E+01	95% Student's-t UCL	Nonparametric		7.67E+01		Arith Mean	7.88E+01		95% UCL
	pH	S.U.	316	316	0	0%	N/A	N/A	7.37E+00	6.3	9.5	7.37E+00	7.4	7.42E+00	95% Student's-t UCL	Nonparametric		7.37E+00		Arith Mean	7.42E+00		95% UCL
	Solids, total dissolved	mg/L	249	249	0	0%	N/A	N/A	1.46E+02	52	257	1.46E+02	142	1.50E+02	95% Student's-t UCL	Normal		1.46E+02		Arith Mean	1.50E+02		95% UCL
	Specific Conductance @ 25	uS/cm	319	319	0	0%	N/A	N/A	1.83E+02	67	396	1.83E+02	175	1.88E+02	95% Approximate Gamma UCL	Gamma		1.83E+02		Arith Mean	1.88E+02		95% UCL
	Sulfate, as SO4	mg/L	268	268	0	0%	N/A	N/A	1.77E+01	2.45	39	1.81E+01	18	1.83E+01	95% Student's-t UCL	Nonparametric		1.81E+01		Arith Mean	1.83E+01		95% UCL
	Mercury, total	ng/L	4	4	0	0%	N/A	N/A	4.60E+00	1.1	9.4	4.60E+00	3.95	N/A	Insufficient detects for UCL	N/A		4.60E+00		Arith Mean	9.40E+00		Max D
USGS 04187500	Mercury, total	ng/L	3	3	0	0%	N/A	N/A	4.13E+00	1.5	8.9	4.13E+00	2	N/A	Insufficient detects for UCL	N/A		4.13E+00		Arith Mean	8.90E+00		Max D
SW004a	Mercury, total	ng/L	19	19	0	0%	N/A	N/A	3.82E+00	0.79	12.5	3.82E+00	2.98	5.05E+00	95% Student's-t UCL	Normal		3.82E+00		Arith Mean	5.05E+00		95% UCL
	Aluminum, total	mg/L	55	25	30	55%	0.0004	0.025	1.55E-02	0.0116	0.0637	2.30E-02	0.0233	2.00E-02	95% KM Approximate Gamma UCL	Gamma		2.33E-02	2.33E+01	Median	6.37E-02	6.37E+01	Max D
	Antimony, total	mg/L	11	0	11	100%	0.0005	0.0005	N/A	N/A	N/A	5.00E-04	0.0005	N/A	Insufficient detects for UCL	N/A	<	5.00E-04	5.00E-01	Median	5.00E-04	5.00E-01	Max ND
	Arsenic, total	mg/L	41	19	22	54%	0.00031	0.002	6.03E-04	0.00033	0.002	8.30E-04	0.00051	6.95E-04	95% H-UCL	Lognormal		5.10E-04	5.10E-01	Median	6.95E-04	6.95E-01	95% UCL
	Boron, total	mg/L	98	96	2	2%	0.1	0.1	2.11E-01	0.092	0.311	2.11E-01	0.229	2.21E-01	95% KM (t) UCL	Nonparametric		2.11E-01	2.11E+02	KM Mean	2.21E-01	2.21E+02	95% UCL
	Cadmium, total	mg/L	27	2	25	93%	0.0002	0.0002	7.35E-05	0.00005	0.000097	1.91E-04	0.0002	N/A	Insufficient detects for UCL	N/A	<	2.00E-04	2.00E-01	Median	2.00E-04	2.00E-01	Max ND
	Chromium, total	mg/L	20	3	17	85%	0.001	0.001	1.05E-03	0.0011	0.0017	1.05E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	1.70E-03	1.70E+00	Max D
	Cobalt, total	mg/L	102	49	53	52%	0.0002	0.005	3.43E-04	0.00017	0.001	8.82E-04	0.00048	3.83E-04	95% KM (t) UCL	Nonparametric	<	4.80E-04	4.80E-01	Median	1.00E-03	1.00E+00	Max D
	Copper, total	mg/L	68	50	18	26%	0.0005	0.01	9.59E-04	0.00055	0.00202	1.42E-03	0.00094	1.04E-03	95% KM (t) UCL	Nonparametric		9.59E-04	9.59E-01	KM Mean	1.04E-03	1.04E+00	95% UCL
	Lead, total	mg/L	54	2	52	96%	0.00003	0.001	7.40E-05	0.000083	0.001	5.91E-04	0.0005	N/A	Insufficient detects for UCL	N/A	<	5.00E-04	5.00E-01	Median	1.00E-03	1.00E+00	Max D
	Nickel, total	mg/L	60	36	24	40%	0	0.005	1.11E-03	0.00051	0.005	1.54E-03	0.001	2.81E-03	95% KM (Chebyshev) UCL	Nonparametric		1.11E-03	1.11E+00	KM Mean	2.81E-03	2.81E+00	95% UCL
SD026/PM7	Selenium, total	mg/L	31	3	28	90%	0.001	0.0036	1.82E-04	0.000037	0.002	1.50E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	2.00E-03	2.00E+00	Max D
	Silver, total	mg/L	17	1	16	94%	0.0002	0.001	2.47E-04	0.001	0.001	4.45E-04	0.00024	N/A	Insufficient detects for UCL	N/A	<	2.40E-04	2.40E-01	Median	1.00E-03	1.00E+00	Max D
	Thallium, total	mg/L	21	2	19	90%	0.000002	0.0002	2.17E-06	0.000002	0.000003	6.92E-05	0.000005	N/A	Insufficient detects for UCL	N/A	<	5.00E-06	5.00E-03	Median	2.00E-04	2.00E-01	Max ND
	Zinc, total	mg/L	68	25	43	63%	0.00024	0.025	6.52E-03	0.002	0.0825	1.08E-02	0.0075	1.68E-02	95% KM H-UCL	Lognormal		7.50E-03	7.50E+00	Median	1.68E-02	1.68E+01	95% UCL
	Chloride	mg/L	155	155	0	0%	N/A	N/A	1.15E+01	3.1	21.5	1.15E+01	11.2	1.20E+01	95% Student's-t UCL	Normal		1.15E+01		Arith Mean	1.20E+01		95% UCL
	Hardness, as CaCO3	mg/L	220	220	0	0%	N/A	N/A	4.66E+02	175	780	4.66E+02	469.5	4.79E+02	95% Student's-t UCL	Nonparametric		4.66E+02		Arith Mean	4.79E+02		95% UCL
	pH	S.U.	296	296	0	0%	N/A	N/A	7.82E+00	6.77	8.7	7.82E+00	7.89	7.85E+00	95% Student's-t UCL	Normal		7.82E+00		Arith Mean	7.85E+00		95% UCL
	Solids, total dissolved	mg/L	155	155	0	0%	N/A	N/A	6.50E+02	350	1540	6.50E+02	677	6.69E+02	95% Student's-t UCL	Nonparametric		6.50E+02		Arith Mean	6.69E+02		95% UCL
	Specific Conductance @ 25	uS/cm	299	299	0	0%	N/A	N/A	1.01E+03	1	1393	1.00E+03	1039	1.02E+03	95% Student's-t UCL	Nonparametric		1.00E+03		Arith Mean	1.02E+03		95% UCL
	Sulfate, as SO4	mg/L	154	153	1	1%	1	1	1.73E+02	97.4	360	1.74E+02	175	1.79E+02	95% KM (t) UCL	Normal		1.73E+02		KM Mean	1.79E+02		95% UCL
	Mercury, total	ng/L	89	47	42	47%	0.1	25	6.03E-01	0.18	2.1	1.56E+00	0.6	6.82E-01	95% KM Approximate Gamma UCL	Gamma		6.03E-01		KM Mean	6.82E-01		95% UCL
	Aluminum, total	mg/L	38	28	10	26%	0.02	0.04	2.36E-02	0.0102	0.0764	2.53E-02	0.0222	2.69E-02	95% KM (t) UCL	Normal		2.36E-02	2.36E+01	KM Mean	2.69E-02	2.69E+01	95% UCL
	Antimony, total	mg/L	17	0	17	100%	0.0005	0.0005	N/A	N/A	N/A	5.00E-04	0.0005	N/A	Insufficient detects for UCL	N/A	<	5.00E-04	5.00E-01	Median	5.00E-04	5.00E-01	Max ND
	Arsenic, total	mg/L	38	20	18	47%	0.00031	0.00082	9.03E-04	0.0005	0.0037	9.93E-04	0.000515	1.23E-03	95% KM Adjusted Gamma UCL	Gamma		9.03E-04	9.03E-01	KM Mean	1.23E-03	1.23E+00	95% UCL
	Boron, total	mg/L	12	11	1	8%	0.1	0.1	1.42E-01	0.114	0.185	1.42E-01	0.142	1.55E-01	95% KM (t) UCL	Normal		1.42E-01	1.42E+02	KM Mean	1.55E-01	1.55E+02	95% UCL
	Cadmium, total	mg/L	12	0	12	100%	0.0002	0.0002	N/A	N/A	N/A	2.00E-04	0.0002	N/A	Insufficient detects for UCL	N/A	<	2.00E-04	2.00E-01	Median	2.00E-04	2.00E-01	Max ND
	Chromium, total	mg/L	12	0	12	100%	0.001	0.001	N/A	N/A	N/A	1.00E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	1.00E-03	1.00E+00	Max ND
	Cobalt, total	mg/L	38	18	20	53%	0.0002	0.0002	2.87E-04	0.0002	0.00072	2.87E-04	0.0002	3.29E-04	95% KM (t) UCL	Normal	<	2.00E-04	2.00E-01	Median	3.29E-04	3.29E-01	95% UCL

	Copper, total	mg/L	38	17	21	55%	0.0005	0.0005	6.57E-04	0.00051	0.0036	6.57E-04	0.0005	7.98E-04	95% KM (t) UCL	Nonparametric	<	5.00E-04	5.00E-01	Median	7.98E-04	7.98E-01	95% UCL
	Lead, total	mg/L	38	0	38	100%	0.0005	0.0005	N/A	N/A	N/A	5.00E-04	0.0005	N/A	Insufficient detects for UCL	N/A	<	5.00E-04	5.00E-01	Median	5.00E-04	5.00E-01	Max ND
	Nickel, total	mg/L	38	10	28	74%	0.0005	0.001	5.59E-04	0.00052	0.0012	5.72E-04	0.0005	6.05E-04	95% KM (t) UCL	Nonparametric	<	5.00E-04	5.00E-01	Median	6.05E-04	6.05E-01	95% UCL
TC-1A	Selenium, total	mg/L	24	0	24	100%	0.001	0.001	N/A	N/A	N/A	1.00E-03	0.001	N/A	Insufficient detects for UCL	N/A	<	1.00E-03	1.00E+00	Median	1.00E-03	1.00E+00	Max ND
	Silver, total	mg/L	5	0	5	100%	0.0002	0.0002	N/A	N/A	N/A	2.00E-04	0.0002	N/A	Insufficient detects for UCL	N/A	<	2.00E-04	2.00E-01	Median	2.00E-04	2.00E-01	Max ND
	Thallium, total	mg/L	24	0	24	100%	0.0000004	0.00002	N/A	N/A	N/A	5.61E-06	0.000005	N/A	Insufficient detects for UCL	N/A	<	5.00E-06	5.00E-03	Median	2.00E-05	2.00E-02	Max ND
	Zinc, total	mg/L	38	2	36	95%	0.006	0.006	6.16E-03	0.0066	0.0115	6.16E-03	0.006	N/A	Insufficient detects for UCL	N/A	<	6.00E-03	6.00E+00	Median	1.15E-02	1.15E+01	Max D
	Chloride	mg/L	38	38	0	0%	N/A	N/A	1.73E+01	6.6	33.5	1.73E+01	15.2	1.95E+01	95% Student's-t UCL	Nonparametric		1.73E+01		Arith Mean	1.95E+01		95% UCL
	Hardness, as CaCO3	mg/L	38	38	0	0%	N/A	N/A	3.31E+02	144	547	3.31E+02	289	3.66E+02	95% KM Adjusted Gamma UCL	Gamma		3.31E+02		Arith Mean	3.66E+02		95% UCL
	pH	S.U.	38	38	0	0%	N/A	N/A	7.37E+00	6.85	7.82	7.37E+00	7.41	7.44E+00	95% Student's-t UCL	Normal		7.37E+00		Arith Mean	7.44E+00		95% UCL
	Solids, total dissolved	mg/L	38	38	0	0%	N/A	N/A	4.74E+02	231	722	4.74E+02	433.5	5.11E+02	95% Student's-t UCL	Normal		4.74E+02		Arith Mean	5.11E+02		95% UCL
	Specific Conductance @ 25	uS/cm	38	38	0	0%	N/A	N/A	7.24E+02	345.6	1150	7.23E+02	676.3	7.95E+02	95% Adjusted Gamma UCL	Gamma		7.23E+02		Arith Mean	7.95E+02		95% UCL
	Sulfate, as SO4	mg/L	38	36	2	5%	2	2	5.14E+01	1	132	5.14E+01	55.5	6.22E+01	95% KM (t) UCL	Normal		5.14E+01		KM Mean	6.22E+01		95% UCL
	Mercury, total	ng/L	12	12	0	0%	N/A	N/A	2.13E+00	0.77	5.1	2.13E+00	1.97	2.81E+00	95% Student's-t UCL	Normal		2.13E+00		Arith Mean	2.81E+00		95% UCL

Summary of Baseline Water Quality and MeasurableChange Conclusions
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					SD026				Trimble Creek Wetlands				Unnamed Creek Wetlands				TC-1a				
Parameter		Units	Applicable Standard(1)	Typical Reporting Limit (PQL)(2)	Existing Average Water Quality (substitution method)(3)		ProUCL Existing Water Quality Central Tendency(4)	LSC and UCL Measurable Increase Conclusion Same?	Existing Average Water Quality (substitution method)(3)		ProUCL Existing Water Quality Central Tendency(4)	LSC and UCL Measurable Increase Conclusion Same?	Existing Average Water Quality (substitution method)(3)		ProUCL Existing Water Quality Central Tendency(4)	LSC and UCL Measurable Increase Conclusion Same?	Existing Average Water Quality (substitution method)(3)		ProUCL Existing Water Quality Central Tendency(4)	LSC and UCL Measurable Increase Conclusion Same?	Parameter
Aluminum (total)	Al	µg/L	125	2	18.4		23.3	Yes	22.4		23.6	Yes	17		29.9	Yes	22.4		23.6	No	Al
Antimony (total)	Sb	µg/L	31	0.53	0.86	<	0.5	Yes	n.d.	<	0.5	Yes	n.d.	<	0.5	Yes	n.d.	<	0.50	Yes	Sb
Arsenic (total)	As	µg/L	53	0.5	0.62		0.51	Yes	0.87		0.90253	Yes	0.87		0.92	Yes	0.87		0.90	Yes	As
Boron (total)	B	µg/L	500	100	210		211	No - UCL indicates measurable change	138		142	Yes	207		210	Yes	138		142	No - UCL indicates measurable change	B
Cadmium (total)	Cd	µg/L	2.5(7)	0.2	n.d.	<	0.2	Yes	n.d.	<	0.2	Yes	n.d	<	0.2	Yes	n.d.	<	0.2	Yes	Cd
Chromium (total)	Cr	µg/L	11(7)	1	n.d.	<	1	Yes	n.d.	<	1	Yes	n.d	<	1	Yes	n.d.	<	1	Yes	Cr
Cobalt (total)	Co	µg/L	5	0.2	0.54	<	0.48	No- change not measurable using UCL	0.23	<	0.2	Yes	0.3	<	0.2	Yes	0.23	<	0.2	Yes	Co
Copper (total)	Cu	µg/L	9.3(7)	0.5	1.11		0.96	Yes	0.52	<	0.5	Yes	0.93		0.84	Yes	0.52	<	0.5	Yes	Cu
Lead (total)	Pb	µg/L	3.2(7)	0.5	n.d.	<	0.5	Yes	n.d.	<	0.5	Yes	n.d	<	0.5	Yes	n.d.	<	0.5	Yes	Pb
Nickel (total)	Ni	µg/L	52(7)	0.5	1.32		1.11	Yes	n.d.	<	0.5	Yes	0.68		0.57	Yes	n.d.	<	0.5	Yes	Ni
Selenium (total)	Se	µg/L	5	1	n.d.	<	1	No- change not measurable using UCL	n.d.	<	1	Yes	n.d	<	1	No- change not measurable using UCL	n.d.	<	1	Yes	Se
Silver (total)	Ag	µg/L	1	0.2	0.25	<	0.24	Yes	n.d.	<	0.2	Yes	n.d.	<	0.2	No- change not measurable using UCL	n.d.	<	0.2	Yes	Ag
Thallium	Tl	µg/L	0.56	0.005	0.26	<	0.005	Yes	n.d.	<	0.005	Yes	0.12		0.0075	Yes	n.d.	<	0.005	Yes	Tl
Zinc (total)	Zn	µg/L	120(7)	6	8.2		7.5	Yes	n.d.	<	6	Yes	n.d	<	6	Yes	n.d.	<	6	Yes	Zn
Chloride	Cl	mg/L	230	5	11.5		11.5	Yes	17.3		17.3	Yes	17		17.0	Yes	17.3		17.3	Yes	Cl
Hardness (as $CaCO_3$)		mg/L	500	10	439		466	Yes	331		331	Yes	373		373	Yes	331		331	Yes	hardness
pH		SU	6.5 to 8.5	0.01	7.8		7.8	Yes	7.4		7.4	Yes	7.6		7.6	Yes	7.4		7.37	Yes	pH
Solids, total dissolved(9)		mg/L	700	10	650		650	Yes	474		474	Yes	492		492	Yes	474		474	Yes	TDS
Specific Conductance @ 25°C(10)		µS/cm	1,000	0	997		1005	Yes	723		723	Yes	793		793	Yes	723		723	Yes	Sp. Cond.
Sulfate	SO_4	mg/L	none(8)	1	173		173	Yes	51.4		51.4	Yes	114		115	Yes	51.4		51	Yes	SO_4

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(4) Central Tendency determined as described in Table 1.

(5) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after ther monitoring data w

(6) Central Tendency determined as described in Table 1, adjusted for flows from the LTVSMC pits that began after ther monitoring data was collected.

Summary of Baseline Water Quality and MeasurableChange Conclusions
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PM-11				PM-13				MNSW8				MNSW12				Scanlon			
Existing Average Water Quality (substitution method)[3]		ProUCL Existing Water Quality Central Tendency[4]	LSC and UCL Measurable Increase Conclusion Same?	Existing Average Water Quality (substitution method)[3]		ProUCL Existing Water Quality Central Tendency[4]	LSC and UCL Measurable Increase Conclusion Same?	Existing Average Water Quality (substitution method)[5]		ProUCL Existing Water Quality Central Tendency[6]	LSC and UCL Measurable Increase Conclusion Same?	Existing Average Water Quality (substitution method)[5]		ProUCL Existing Water Quality Central Tendency[6]	LSC and UCL Measurable Increase Conclusion Same?	Existing Average Water Quality (substitution method)[5]		ProUCL Existing Water Quality Central Tendency[6]	LSC and UCL Measurable Increase Conclusion Same?
29.5		29.9	Yes	187		180.84	No	35.9		35.9	Yes	96.5		96.7	Yes	100		101	Yes
n.d.	<	0.5	Yes	n.d.	<	0.50	Yes	n.d.		0.10	Yes	n.d.		0.1		Not Available		Not Available	Yes
0.87		0.92	Yes	1.1		1.1	Yes	1.42		1.50	Yes	1.04		1.02	Yes	1.47		1.64	Yes
207		210	Yes	n.d		59.5	Yes	107		107	Yes	108		104	Yes	112		112	Yes
n.d.	<	0.2	Yes	n.d	<	0.2	Yes	n.d.	<	0.14	Yes	n.d.	<	0.19	Yes	1.36	<	1.00	Yes
n.d.	<	1	Yes	n.d	<	1	No- change not measurable using UCL	n.d.		0.71	Yes	n.d.		0.61	Yes	6.4		6.2	Yes
0.3	<	0.2	Yes	0.44		0.41	Yes	0.73		0.73	Yes	0.5		0.48	Yes	1.49	<	2.99	Yes
0.93		0.84	Yes	1.32		1.2	Yes	1.18		1.23	No- change not measurable using UCL	3.17		3.2	Yes	7.5		7.4	Yes
n.d.	<	0.5	Yes	n.d	<	0.5	Yes	n.d.		0.24	Yes	n.d.		0.27	Yes	1.77	<	1.99	Yes
0.68		0.57	Yes	1.46		1.4	Yes	4.12		4.09	Yes	3.64		3.51	Yes	1.15	<	1.01	Yes
n.d.	<	1	No- change not measurable using UCL	n.d.	<	1	Yes	n.d.		0.97	Yes	n.d.		0.6	Yes	1.0	<	1.0	Yes
n.d.	<	0.2	Yes	n.d.	<	0.22	Yes	n.d.		0.06	Yes	n.d.		0.0	Yes	0.52	<	1.00	Yes
0.0075		0.0075	No - UCL indicates measurable change	0.135	<	0.005	No - UCL indicates measurable change	0.2	<	0.31	Yes	0.2	<	0.4	No - UCL indicates measurable change	Not Available		Not Available	Yes
n.d.	<	6	Yes	7.0	<	6	Yes	n.d.		4.86	Yes	n.d.		4.3	Yes	18.8		18.7	Yes
17		17.0	Yes	7.3		7.0	Yes	16.5		16.5	Yes	7.1		6.6	Yes	8.2		8.2	Yes
373		373	Yes	139		139	Yes	806		785	Yes	356		331	Yes	80		80	Yes
7.6		7.6	Yes	7.4		7.4	Yes	7.99		7.99	Yes	7.66		7.7	No	7.4		7.4	Yes
492		492	Yes	227		227	Yes	967		970	Yes	452		428	No	150		150	Yes
793		793	Yes	284		284	Yes	1336		1336	Yes	700		840	No	189		188	Yes
115		115	Yes	53		51	Yes	472		471	Yes	202		190	Yes	19.7		20.1	Yes

as collected. (See Attachment E of the Antidegradation Evaluation for details)

Second Creek Headwaters Segment (SD026) (Receiving Water)
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
Antidegradation Results and ProUCL Results

								2016 Draft Antidegradation			ProUCL (Non-substitution methods)			
Parameter		Units	Applicable Standard[1]	Typical Reporting Limit (PQL)[2]	Number of Samples (n)	Percentage Non-Detect	Estimated Future Water Quality Mine Year 10 [3]	Existing Average Water Quality (substitution method)[4]	Upper LCS Limit[5]	Measurable Increase by LCS method?[6]	Existing Water Quality Central Tendency[7]	95th Percentile UCL[8]	Measurable Increase by UCL Method? [9]	LSC and UCL Measurable Increase Conclusion Same?
Aluminum (total)	Al	µg/L	125	2	55	55%	6.3	18.4	21.2	No	23.3	63.7	No	Yes
Antimony (total)	Sb	µg/L	31	0.53	11	100%	6.3	0.86	1	Yes	< 0.5	0.5	Yes	Yes
Arsenic (total)	As	µg/L	53	0.5	41	54%	10	0.62	0.70	Yes	0.51	0.69	Yes	Yes
Boron (total)	B	µg/L	500	100	98	2%	230	210	242	No	211	211	Yes	No
Cadmium (total)	Cd	µg/L	2.5[10]	0.2	27	93%	0.71	n.d.	N/A	Yes	< 0.2	0.2	Yes	Yes
Chromium (total)	Cr	µg/L	11[10]	1	20	85%	5.3	n.d.	N/A	Yes	< 1	1.7	Yes	Yes
Cobalt (total)	Co	µg/L	5	0.2	102	52%	5	0.54	0.62	Yes	< 0.48	1	Yes	No
Copper (total)	Cu	µg/L	9.3[10]	0.5	68	26%	9	1.11	1.3	Yes	0.96	1.04	Yes	Yes
Lead (total)	Pb	µg/L	3.2[10]	0.5	54	96%	3	n.d.	N/A	Yes	< 0.5	1	Yes	Yes
Nickel (total)	Ni	µg/L	52[10]	0.5	60	40%	50	1.32	1.5	Yes	1.11	2.81	Yes	Yes
Selenium (total)	Se	µg/L	5	1	31	90%	1.6	n.d.	N/A	Yes	< 1	2	No	No
Silver (total)	Ag	µg/L	1	0.2	17	94%	0.21	0.25	0.29	No	< 0.24	1	No	Yes
Thallium (total)	Tl	µg/L	0.56	0.005	21	90%	0.16	0.26	0.3	No	< 0.005	0.2	No	Yes
Zinc (total)	Zn	µg/L	120[10]	6	68	63%	57.1	8.2	9.4	Yes	7.5	16.8	Yes	Yes
Chloride	Cl	mg/L	230	5	155	0%	23.4	11.5	12.5	Yes	11.5	12	Yes	Yes
Hardness (as $CaCO_3$)		mg/L	500	10	220	0%	100	439	505	No	466	479	No	Yes
pH		SU	6.5 to 8.5	0.01	296	0%	8.4	7.83	8.0	Yes	7.8	7.9	Yes	Yes
Solids, total dissolved[12]		mg/L	700	10	155	0%	464	650	780	No	650	669	No	Yes
Specific Conductance @ 25°C[13]		µS/cm	1,000	0	299	0%	960	997	1007	No	1005	1020	No	Yes
Sulfate	SO_4	mg/L	none[11]	1	154	1%	10	173	189.2	No	173	179	No	Yes

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Anticipated water quality at the outfalls is equal to the antidegradation discharge quality (see Section 5.7 of Antidegradation Evaluation). No mixing is assumed.

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(7) Central Tendency determined as described in Table 1.

(8) 95% UCL determined as described in Table 2.

(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) The proposed receiving waters are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used

Trimble Creek Headwaters Wetlands (Receiving Water)
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
2016 Draft Antidegradation Conclusions and ProUCL results

Parameter		Units	Applicable Standard[1]	Typical Reporting Limit (PQL)[2]	Number of Samples (n)	Percentage Non-Detect	Estimated Future Water Quality Mine Year 10 [3]	2016 Draft Antidegradation: Existing Average Water Quality (substitution method)[4]	2016 Draft Antidegradation: Upper LCS Limit[5]	2016 Draft Antidegradation: Measurable Increase by LCS method?[6]	ProUCL (Non-substitution methods): Existing Water Quality Central Tendency[7]	ProUCL (Non-substitution methods): 95th Percentile UCL[8]	ProUCL (Non-substitution methods): Measurable Increase by UCL Method? [9]	LSC and UCL Measurable Increase Conclusion Same?
Aluminum (total)	Al	µg/L	125	2	38	26%	6.3	22.4	25.8	No	23.6	26.9	No	Yes
Antimony (total)	Sb	µg/L	31	0.53	17	100%	6.3	n.d.	N/A	Yes	< 0.5	0.5	Yes	Yes
Arsenic (total)	As	µg/L	53	0.5	38	47%	10	0.87	1	Yes	0.90253	1.23	Yes	Yes
Boron (total)	B	µg/L	None	100	12	8%	230	138	159	Yes	142	155	Yes	Yes
Cadmium (total)	Cd	µg/L	2.5[10]	0.2	12	100%	0.71	n.d.	N/A	Yes	< 0.2	0.2	Yes	Yes
Chromium (total)	Cr	µg/L	11[10]	1	12	100%	5.3	n.d.	N/A	Yes	< 1	1	Yes	Yes
Cobalt (total)	Co	µg/L	5	0.2	38	53%	5	0.23	0.26	Yes	< 0.2	0.33	Yes	Yes
Copper (total)	Cu	µg/L	9.3[10]	0.5	38	55%	9	0.52	0.6	Yes	< 0.5	0.80	Yes	Yes
Lead (total)	Pb	µg/L	3.2[10]	0.5	38	100%	3	n.d.	N/A	Yes	< 0.5	0.5	Yes	Yes
Nickel (total)	Ni	µg/L	52[10]	0.5	38	74%	50	n.d.	N/A	Yes	< 0.5	0.61	Yes	Yes
Selenium (total)	Se	µg/L	5	1	24	100%	1.6	n.d.	N/A	Yes	< 1	1	Yes	Yes
Silver (total)	Ag	µg/L	1	0.2	5	100%	0.21	n.d.	N/A	Yes	< 0.2	0.2	Yes	Yes
Thallium (total)	Tl	µg/L	0.56	0.005	24	100%	0.16	n.d.	N/A	Yes	< 0.005	0.02	Yes	Yes
Zinc (total)	Zn	µg/L	120[10]	6	38	95%	57.1	n.d.	N/A	Yes	< 6	11.5	Yes	Yes
Chloride	Cl	mg/L	230	5	38	0%	23.4	17.3	19	Yes	17.3	19.5	Yes	Yes
Hardness (as $CaCO_3$)		mg/L	Maintain Background [11]	10	38	0%	100	331	381	No	331	366	No	Yes
pH		SU	Maintain Background [11]	0.01	38	0%	8.4	7.4	7.6	Yes	7.4	7.4	Yes	Yes
Solids, total dissolved[13]		mg/L	None	10	38	0%	464	474	569	No	474	511	No	Yes
Specific Conductance @ 25°C[14]		µS/cm	None	0	38	0%	960	723	730	Yes	723	795	Yes	Yes
Sulfate	SO_4	mg/L	none[12]	1	38	5%	10	51.4	57	No	51	62	No	Yes

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Anticipated water quality at the outfalls is equal to the antidegradation discharge quality (see Section 5.7 of Antidegradation Evaluation). No mixing is assumed.

(4) Existing conditions estimated based on stream monitoring data from TC-1a as discussed in Section 5.5 of the Antidegradation Evaluation. Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(7) Central Tendency determined as described in Table 1.

(8) 95% UCL determined as described in Table 2.

(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) Maintain background "means the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses." (Minnesota Rules, part 7050.0222, subpart 6(B) and part 7050.0223, subpart 5

(12) The proposed receiving waters are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(13) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(14) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis

Unnamed Creek Headwaters Wetlands
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters (Receiving Water)
2016 Draft Antidegradation Conclusions and ProUCL results

Parameter		Units	Applicable Standard(1)	Typical Reporting Limit (PQL)(2)	Number of Samples (n)	Percentage Non-Detect	Estimated Future Water Quality Mine Year 10(3)	2016 Draft Antidegradation: Existing Average Water Quality (substitution method)(4)	2016 Draft Antidegradation: Upper LCS Limit(5)	2016 Draft Antidegradation: Measurable Increase by LCS method?(6)	ProUCL (Non-substitution methods): Existing Water Quality Central Tendency(7)	ProUCL (Non-substitution methods): 95th Percentile UCL(8)	ProUCL (Non-substitution methods): Measurable Increase by UCL Method?(9)	LSC and UCL Measurable Increase Conclusion Same?
Aluminum (total)	Al	µg/L	125	2	66	27%	6.3	29.5	N/A	No	29.9	34	No	Yes
Antimony (total)	Sb	µg/L	31	0.53	35	100%	6.3	n.d.	N/A	Yes	< 0.5	3	Yes	Yes
Arsenic (total)	As	µg/L	53	0.5	58	40%	10	0.87	1	Yes	0.92	1.03	Yes	Yes
Boron (total)	B	µg/L	None	100	23	4%	230	207	238	No	210	232	No	Yes
Cadmium (total)	Cd	µg/L	2.5(10)	0.2	26	81%	0.71	n.d	N/A	Yes	< 0.2	0.2	Yes	Yes
Chromium (total)	Cr	µg/L	11(10)	1	26	81%	5.3	n.d	N/A	Yes	< 1	2.3	Yes	Yes
Cobalt (total)	Co	µg/L	5	0.2	64	73%	5	0.3	0.35	Yes	< 0.2	0.83	Yes	Yes
Copper (total)	Cu	µg/L	9.3(10)	0.5	66	20%	9	0.93	1.07	Yes	0.84	0.92	Yes	Yes
Lead (total)	Pb	µg/L	3.2(10)	0.5	60	90%	3	n.d	N/A	Yes	< 0.5	1.00	Yes	Yes
Nickel (total)	Ni	µg/L	52(10)	0.5	66	62%	50	0.68	0.78	Yes	0.57	0.74	Yes	Yes
Selenium (total)	Se	µg/L	5	1	42	93%	1.6	n.d	N/A	yes	< 1	3.6	No	No
Silver (total)	Ag	µg/L	1	0.2	21	100%	0.21	n.d.	N/A	Yes	< 0.2	1	No	No
Thallium (total)	Tl	µg/L	0.56	0.005	47	89%	0.16	0.12	0.14	Yes	0.0075	0.0092	Yes	Yes
Zinc (total)	Zn	µg/L	120(10)	6	66	89%	57.1	n.d	N/A	yes	< 6	41.2	Yes	Yes
Chloride	Cl	mg/L	230	5	81	0%	23.4	17	18.7	Yes	17.0	18.6	Yes	Yes
Hardness (as $CaCO_3$)		mg/L	Maintain Background(11)	10	66	0%	100	373	429	No	373	407	No	Yes
pH		SU	Maintain Background (11)	0.01	76	0%	8.4	7.6	7.8	Yes	7.6	7.6	Yes	Yes
Solids, total dissolved(13)		mg/L	None	10	66	0%	464	492	590	No	492	532	No	Yes
Specific Conductance @ 25°C(14)		µS/cm	None	0	70	0%	960	793	801	Yes	793	849	Yes	Yes
Sulfate	SO_4	mg/L	none(12)	1	85	0%	10	114	125	No	115	146	No	Yes

n.d. -- All measured values are below reporting limits or the average value is below the reporting limit.
N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Anticipated water quality at the outfalls is equal to the antidegradation discharge quality (see Section 5.7 of Antidegradation Evaluation). No mixing is assumed.

(4) Existing conditions estimated based on stream monitoring data from TC-1a as discussed in Section 5.5 of the Antidegradation Evaluation. Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(7) Central Tendency determined as described in Table 1.

(8) 95% UCL determined as described in Table 2.

(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) Maintain background "means the concentration of the water quality substances, characteristics, or pollutants shall not deviate from the range of natural background concentrations or conditions such that there is a potential significant adverse impact to the designated uses." (Minnesota Rules, part 7050.0222, subpart 6(B) and part 7050.0223, subpart 5)

(12) The proposed receiving waters are not listed wild rice waters, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(13) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(14) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis

Trimble Creek at TC-1a (Embarras River Watershed)
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
2016 Draft Antidegradation Conclusions and ProUCL results

								2016 Draft Antidegradation			ProUCL (Non-substitution methods)			
Parameter		Units	Applicable Standard[1]	Typical Reporting Limit (PQL)[2]	Number of Samples (n)	Percentage Non-Detect	Estimated Future Water Quality Mine Year 10[3]	Existing Average Water Quality (substitution method)[4]	Upper LCS Limit[5]	Measurable Increase by LCS method?[6]	Existing Water Quality Central Tendency[7]	95th Percentile UCL[8]	Measurable Increase by UCL Method?[9]	LSC and UCL Measurable Increase Conclusion Same?
Aluminum (total)	Al	µg/L	125	2	38	26%	19.6	22.4	--[14]	No	23.6	26.9	No	Yes
Antimony (total)	Sb	µg/L	31	0.53	17	100%	5.2	n.d.	N/A	Yes	< 0.5	0.5	Yes	Yes
Arsenic (total)	As	µg/L	53	0.5	38	47%	8.9	0.87	1	Yes	0.90	1.2	Yes	Yes
Boron (total)	B	µg/L	500	100	12	8%	159	138	159	No	142	155	Yes	No
Cadmium (total)	Cd	µg/L	2.5[10]	0.2	12	100%	0.6	n.d.	N/A	Yes	< 0.2	0.2	Yes	Yes
Chromium (total)	Cr	µg/L	11[10]	1	12	100%	4.5	n.d.	N/A	Yes	< 1	1	Yes	Yes
Cobalt (total)	Co	µg/L	5	0.2	38	53%	4.5	0.23	0.26	Yes	< 0.2	0.33	Yes	Yes
Copper (total)	Cu	µg/L	9.3[10]	0.5	38	55%	7.9	0.52	0.6	Yes	< 0.5	0.80	Yes	Yes
Lead (total)	Pb	µg/L	3.2[10]	0.5	38	100%	2.6	n.d.	N/A	Yes	< 0.5	0.5	Yes	Yes
Nickel (total)	Ni	µg/L	52[10]	0.5	38	74%	43.1	n.d.	N/A	Yes	< 0.5	0.61	Yes	Yes
Selenium (total)	Se	µg/L	5	1	24	100%	1.4	n.d.	N/A	Yes	< 1	1	Yes	Yes
Silver (total)	Ag	µg/L	1	0.2	5	100%	0.2	n.d.	N/A	No	< 0.2	0.2	No	Yes
Thallium (total)	Tl	µg/L	0.56	0.005	24	100%	0.14	n.d.	N/A	Yes	< 0.005	0.02	Yes	Yes
Zinc (total)	Zn	µg/L	120[10]	6	38	95%	48.3	n.d.	N/A	Yes	< 6	11.5	Yes	Yes
Chloride	Cl	mg/L	230	5	38	0%	Not Available	17.3	19	N/A	17.3	19.5	N/A	Yes
Hardness (as $CaCO_3$)		mg/L	500	10	38	0%	114	331	381	No	331	366	No	Yes
pH		SU	6.5 to 8.5	0.01	38	0%	Not Available	7.4	7.6	N/A	7.37	7.44	N/A	Yes
Solids, total dissolved[12]		mg/L	700	10	38	0%	145	474	569	No	474	511	No	Yes
Specific Conductance @ 25°C[13]		µS/cm	1,000	0	38	0%	181	723	730	No	723	795	No	Yes
Sulfate	SO_4	mg/L	none[11]	1	38	5%	8.3	51.4	56.5	No	51	62	No	Yes

n.d. -- All measured values are below reporting limits or the average value is below the reporting limit.

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Estimated future water quality is from the FEIS GoldSim water modeling results.

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(7) Central Tendency determined as described in Table 1.

(8) 95% UCL determined as described in Table 2.

(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis

(14) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

Unnamed Creek at PM-11 (Embarras River Watershed)
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
2016 Draft Antidegradation Conclusions and ProUCL results

Parameter		Units	Applicable Standard[1]	Typical Reporting Limit (PQL)[2]	Number of Samples (n)	Percentage Non Detect	Estimated Future Water Quality Mine Year 10 [3]	2016 Draft Antidegradation			ProUCL (Non-substitution methods)			LSC and UCL Measurable Increase Conclusion Same?
								Existing Average Water Quality (substitution method)[4]	Upper LCS Limit[5]	Measurable Increase by LCS method?[6]	Existing Water Quality Central Tendency[7]	95th Percentile UCL[8]	Measurable Increase by UCL Method? [9]	
Aluminum (total)	Al	µg/L	125	2	66	27%	39.2	29.5	N/A	--[14]	29.9	34	--[14]	Yes
Antimony (total)	Sb	µg/L	31	0.53	35	100%	3.9	n.d.	N/A	Yes	< 0.5	3	Yes	Yes
Arsenic (total)	As	µg/L	53	0.5	58	40%	7	0.87	1	Yes	0.92	1.03	Yes	Yes
Boron (total)	B	µg/L	500	100	23	4%	124	207	238	No	210	232	No	Yes
Cadmium (total)	Cd	µg/L	2.5[10]	0.2	26	81%	0.46	n.d.	N/A	Yes	< 0.2	0.2	Yes	Yes
Chromium (total)	Cr	µg/L	11[10]	1	26	81%	3.5	n.d.	N/A	Yes	< 1	2.3	Yes	Yes
Cobalt (total)	Co	µg/L	5	0.2	64	73%	3.7	0.3	0.35	Yes	< 0.2	0.83	Yes	Yes
Copper (total)	Cu	µg/L	9.3[10]	0.5	66	20%	6	0.93	1.07	Yes	0.84	0.92	Yes	Yes
Lead (total)	Pb	µg/L	3.2[10]	0.5	60	90%	2	n.d.	N/A	Yes	< 0.5	1.00	Yes	Yes
Nickel (total)	Ni	µg/L	52[10]	0.5	66	62%	31.9	0.68	0.78	Yes	0.57	0.74	Yes	Yes
Selenium (total)	Se	µg/L	5	1	42	93%	1.2	n.d.	N/A	Yes	< 1	3.6	No	No
Silver (total)	Ag	µg/L	1	0.2	21	100%	0.2	n.d.	N/A	No	< 0.2	1	No	Yes
Thallium (total)	Tl	µg/L	0.56	0.005	47	89%	0.11	0.12	0.14	No	0.0075	0.0092	Yes	No
Zinc (total)	Zn	µg/L	120[10]	6	66	89%	37.1	n.d.	N/A	Yes	< 6	41.2	No	No
Chloride	Cl	mg/L	230	5	81	0%	Not Available	17	18.7	N/A	17.0	18.6	N/A	Yes
Hardness (as $CaCO_3$)		mg/L	500	10	66	0%	85.4	373	429	No	373	407	No	Yes
pH		SU	6.5 to 8.5	0.01	76	0%	Not Available	7.6	7.8	N/A	7.6	7.6	N/A	Yes
Solids, total dissolved[12]		mg/L	700	10	66	0%	204	492	590	No	492	532	No	Yes
Specific Conductance @ 25°C[13]		µS/cm	1,000	0	70	0%	304	793	801	No	793	849	No	Yes
Sulfate	SO_4	mg/L	none[11]	1	85	0%	7	115	125	No	115	146	No	Yes

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Estimated future water quality is from the FEIS GoldSim water modeling results.

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation Evaluation

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(7) Central Tendency determined as described in Table 1.

(8) 95% UCL determined as described in Table 2.

(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis

(14) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

Embarras River at PM-13 (Embarras River Watershed)
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
2016 Draft Antidegradation Conclusions and ProUCL results

							2016 Draft Antidegradation			ProUCL (Non-substitution methods)			
Parameter	Units	Applicable Standard[1]	Typical Reporting Limit (PQL)[2]	Number of Samples (n)	Percentage Non Detect	Estimated Future Water Quality Mine Year 10 [3]	Existing Average Water Quality (substitution method)[4]	Upper LCS Limit[5]	Measurable Increase by LCS method?[6]	Existing Water Quality Central Tendency[7]	95th Percentile UCL[8]	Measurable Increase by UCL Method? [9]	LSC and UCL Measurable Increase Conclusion Same?
Aluminum (total) Al	µg/L	125	2	64	0%	72.5	187	--[14]	No	181	252	No	Yes
Antimony (total) Sb	µg/L	31	0.53	26	100%	1.3	n.d.	N/A	Yes	< 0.5	3	No	No
Arsenic (total) As	µg/L	53	0.5	47	26%	2.9	1.1	1.27	Yes	1.1	1.27	Yes	Yes
Boron (total) B	µg/L	500 / None[9]	100	18	83%	61.2	n.d	N/A	No	59.5	68.9	No	Yes
Cadmium (total) Cd	µg/L	2.5[10]	0.2	21	90%	0.2	n.d	N/A	No	< 0.2	0.26	No	Yes
Chromium (total) Cr	µg/L	11[10]	1	21	76%	1.5	n.d	N/A	Yes	< 1	4.3	No	No
Cobalt (total) Co	µg/L	5	0.2	68	38%	1.8	0.44	0.51	Yes	0.41	0.45	Yes	Yes
Copper (total) Cu	µg/L	9.3[10]	0.5	70	6%	2.5	1.32	1.52	Yes	1.2	1.3	Yes	Yes
Lead (total) Pb	µg/L	3.2[10]	0.5	54	94%	0.76	n.d	N/A	Yes	< 0.5	0.63	Yes	Yes
Nickel (total) Ni	µg/L	52[10]	0.5	70	14%	10.2	1.46	1.7	Yes	1.4	1.5	Yes	Yes
Selenium (total) Se	µg/L	5	1	38	100%	0.74	n.d.	N/A	No	< 1	3.6	No	Yes
Silver (total) Ag	µg/L	1	0.2	16	100%	0.13	n.d.	N/A	No	< 0.22	1	No	Yes
Thallium (total) Tl	µg/L	0.56	0.005	38	79%	0.06	0.135	0.16	No	< 0.005	0.0051	Yes	No
Zinc (total) Zn	µg/L	120[10]	6	98	89%	15.9	7.0	8	Yes	< 6	61.0	No	No
Chloride Cl	mg/L	230	5	83	0%	Not Available	7.3	8	N/A	7.0	11.9	N/A	Yes
Hardness (as $CaCO_3$)	mg/L	500 / Maintain Background[9] [11]	10	68	0%	76.1	139	160	No	139	156	No	Yes
pH	SU	6.5 to 8.5 / Maintain Background[9] [11]	0.01	71	0%	Not Available	7.4	7.62	N/A	7.4	7.5	N/A	Yes
Solids, total dissolved[12]	mg/L	700 / None[9]	10	68	0%	166	227	272	No	227	248	No	Yes
Specific Conductance @ 25°C[13]	µS/cm	1,000 / None[9]	0	71	0%	208	284	287	No	284	317	No	Yes
Sulfate SO_4	mg/L	none[11]	1	87	0%	47.7	53	59	No	51	88.5	No	Yes

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Estimated future water quality is from the FEIS GoldSim water modeling results.

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit.

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value.

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(7) Central Tendency determined as described in Table 1.

(8) 95% UCL determined as described in Table 2.

(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical

(14) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

Second Creek at MNSW8
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
2016 Draft Antidegradation Conclusions and ProUCL results

						2016 Draft Antidegradation				ProUCL (Non-substitution methods)								
Parameter	Units	Applicable Standard[1]	Typical Reporting Limit (PQL)[2]	Number of Samples (n)	Percentage Non Detect	2016 Draft Estimated Future Water Quality [3]	Existing Average Water Quality (substitution method)[4]	Upper LCS Limit[5]	Measurable Increase by LCS method?[6]	Alternative Estimated Future Water Quality [7]		Existing Water Quality Central Tendency[8]	95th Percentile UCL[9]	Estimated Change in Existing Central Tendency due to LTVSMC Pits [14]	Estimated Adjusted Central Tendency [15]	Estimated Adjusted 95th Percentile UCL [16]	Measurable Increase by UCL Method?[17]	LSC and UCL Measurable Increase Conclusion Same?
Aluminum (total) Al	µg/L	125	2	12	0%	35.6	35.9	--[18]	No	35.6		60	113	-23.8	35.9	89.2	No	Yes
Antimony (total) Sb	µg/L	31	0.53	8	13%	0.29	n.d.	N/A	No	0.28		0.064	0.080	+0.03	0.10	0.11	No	Yes
Arsenic (total) As	µg/L	53	0.5	12	42%	1.61	1.42	1.63	No	1.69		1.64	1.97	-0.14	1.50	1.83	No	Yes
Boron (total) B	µg/L	500	100	8	0%	105	107	123	No	105		85	99.5	+21.8	107	121	No	Yes
Cadmium (total) Cd	µg/L	2.5[10]	0.2	8	75%	0.1	n.d.	N/A	No	0.16	<	0.2	0.2	-0.06	0.14	0.14	No	Yes
Chromium (total) Cr	µg/L	11[10]	1	8	25%	0.85	n.d.	N/A	No	0.88		0.57	0.79	+0.13	0.71	0.92	No	Yes
Cobalt (total) Co	µg/L	5	0.2	8	0%	0.84	0.73	0.84	No	0.84		0.77	0.88	-0.05	0.73	0.84	No	Yes
Copper (total) Cu	µg/L	9.3[10]	0.5	8	25%	1.4	1.18	1.36	Yes	1.40		0.78	0.95	+0.45	1.23	1.40	Yes	No
Lead (total) Pb	µg/L	3.2[10]	0.5	8	38%	0.33	n.d.	N/A	No	0.36		0.23	0.94	+0.01	0.24	0.95	No	Yes
Nickel (total) Ni	µg/L	52[10]	0.5	8	0%	5.54	4.12	4.74	Yes	5.51		5.73	6.73	-1.63	4.09	5.10	Yes	Yes
Selenium (total) Se	µg/L	5	1	8	13%	1	n.d.	N/A	No	1.02		0.77	0.96	+0.20	0.97	1.16	No	Yes
Silver (total) Ag	µg/L	1	0.2	8	38%	0.08	n.d.	N/A	No	0.06		0.0083	0.012	+0.05	0.06	0.06	No	Yes
Thallium (total) Tl	µg/L	0.56	0.005	8	100%	0.2	0.2	0.23	No	0.30	<	0.4	0.4	-0.09	0.31	0.31	No	Yes
Zinc (total) Zn	µg/L	120[10]	6	16	6%	6.6	n.d.	N/A	Yes	6.36		4.2	5.08	+0.66	4.86	5.74	Yes	Yes
Chloride Cl	mg/L	230	5	23	0%	15.9	16.5	18.3	No	15.9		8.45	8.76	+8.04	16.5	16.8	No	Yes
Hardness (as $CaCO_3$)	mg/L	500	10	12	0%	795	806	927	No	774		806	887	-20.6	785	866	No	Yes
pH	SU	6.5 to 8.5	0.01	13	0%	Not Available	7.99	N/A	Not Available	Not Available		7.75	7.84	+0.23	7.99	8.07	Not Available	Yes
Solids, total dissolved[12]	mg/L	700	10	12	0%	Not Available	967	N/A	Not Available	Not Available		949	1058	+21.6	970	1080	Not Available	Yes
Specific Conductance @ 25°C[13]	µS/cm	1,000	0	13	0%	Not Available	1336	N/A	Not Available	Not Available		1323	1442	+12.1	1336	1454	Not Available	Yes
Sulfate SO_4	mg/L	none[11]	1	12	0%	464	472	519	No	464		473	529	-1.09	471	528	No	Yes

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.
N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.
(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).
(3) Estimated future water quality estimated with mass balance calculations
(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after ther monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details)
(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of
(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.
(7) Alternative future water quality estimated with mass balance calculations based on central tendency in column N
(8) Central Tendency determined as described in Table 1.
(9) 95% UCL determined as described in Table 2.
(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.
(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.
(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.
(14) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment C.
(15) Existing water quality central tendency plus the change due to LTVSMC pits.
(16) 95th percentile UCL plus the change due to LTVSMC pits.
(17) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.
(18) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

Partridge River at MNSW12
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
2016 Draft Antidegradation Conclusions and ProUCL results

Parameter		Units	Applicable Standard(1)	Typical Reporting Limit (PQL)(2)	Number of Samples (n)	Percentage Non-Detect	2016 Draft Antidegradation: 2016 Draft Estimated Future Water Quality (3)	2016 Draft Antidegradation: Existing Average Water Quality (substitution method)(4)	2016 Draft Antidegradation: Upper LCS Limit(5)	2016 Draft Antidegradation: Measurable Increase by LCS method?(6)	ProUCL (Non-substitution methods): Alternative Estimated Future Water Quality (7)	ProUCL (Non-substitution methods): Existing Water Quality Central Tendency(8)		ProUCL (Non-substitution methods): 95th Percentile UCL(9)	ProUCL (Non-substitution methods): Estimated Change in Existing Central Tendency due to LTVSMC Pits (14)	ProUCL (Non-substitution methods): Estimated Adjusted Central Tendency (15)	ProUCL (Non-substitution methods): Estimated Adjusted 95th Percentile UCL (16)	ProUCL (Non-substitution methods): Measurable Increase by UCL Method?(17)	LSC and UCL Measurable Increase Conclusion Same?
Aluminum (total)	Al	µg/L	125	2	10	0%	96.3	96.5	--(18)	No	96.4		105	136	-8.07	96.7	127.9	No	Yes
Antimony (total)	Sb	µg/L	31	0.53	7	14%	0.15	n.d.	N/A	No	0.13		0.09	0.11	+0.004	0.09	0.11	No	Yes
Arsenic (total)	As	µg/L	53	0.5	10	30%	1.08	1.04	1.16	No	1.06		0.99	1.24	+0.03	1.02	1.27	No	Yes
Boron (total)	B	µg/L	500	100	8	0%	108	108	124	No	104		101.01	122	+2.50	104	124	No	Yes
Cadmium (total)	Cd	µg/L	2.5(10)	0.2	8	88%	0.09	n.d.	N/A	No	0.20	<	0.20	0.2	-0.01	0.19	0.19	No	Yes
Chromium (total)	Cr	µg/L	11(10)	1	8	38%	0.62	n.d.	N/A	No	0.81		0.58	0.95	+0.02	0.61	0.97	No	Yes
Cobalt (total)	Co	µg/L	5	0.2	8	0%	0.52	0.5	0.58	No	0.50		0.46	0.55	+0.02	0.48	0.57	No	Yes
Copper (total)	Cu	µg/L	9.3(10)	0.5	8	0%	3.24	3.17	3.65	No	3.28		3.35	4.01	-0.14	3.21	3.87	No	Yes
Lead (total)	Pb	µg/L	3.2(10)	0.5	8	25%	0.3	n.d.	N/A	No	0.41		0.27	0.41	-0.002	0.27	0.41	No	Yes
Nickel (total)	Ni	µg/L	52(10)	0.5	8	0%	3.95	3.64	419	No	3.82		3.63	4	-0.11	3.51	3.89	No	Yes
Selenium (total)	Se	µg/L	5	1	8	13%	0.66	n.d.	N/A	No	0.63		0.57	0.73	+0.05	0.63	0.78	No	Yes
Silver (total)	Ag	µg/L	1	0.2	8	50%	0.05	n.d.	N/A	No	0.11		0.006	0.007	+0.009	0.02	0.02	No	Yes
Thallium (total)	Tl	µg/L	0.56	0.005	7	100%	0.2	0.2	N/A	No	0.39	<	0.4	0.4	-0.02	0.38	0.38	Yes	No
Zinc (total)	Zn	µg/L	120(10)	6	16	0%	4.03	n.d.	N/A	No	4.50		4.16	4.97	+0.12	4.28	5.09	No	Yes
Chloride	Cl	mg/L	230	5	19	0%	7	7.1	7.8	No	6.6		4.91	5.68	+1.73	6.6	7.4	No	Yes
Hardness (as $CaCO_3$)		mg/L	500	10	10	0%	361	356	409	No	336		291	388	+40.2	331	428	No	Yes
pH		SU	6.5 to 8.5	0.01	11	0%	Not Available	7.66	N/A	Not Available	Not Available		7.61	7.71	+0.05	7.66	7.76	Not Available	Yes
Solids, total dissolved(12)		mg/L	700	10	10	0%	Not Available	452	N/A	Not Available	Not Available		375	490	+52.7	428	543	Not Available	Yes
Specific Conductance @ 25°C(13)		µS/cm	1,000	0	11	0%	Not Available	700	N/A	Not Available	Not Available		793	1173	+47.4	840	1220	Not Available	Yes
Sulfate	SO_4	mg/L	none(11)	1	10	0%	205	202	222	No	193		164	224	+26.1	190	250	No	Yes

n.d. -- All measured values are below reporting limits or the average value is below the reporting limit.

N/A – The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Estimated future water quality estimated with mass balance calculations

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after ther monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details)

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.

(7) Alternative future water quality estimated with mass balance calculations based on central tendency in column N

(8) Central Tendency determined as described in Table 1.

(9) 95% UCL determined as described in Table 2.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis

(14) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment C.

(15) Existing water quality central tendency plus the change due to LTVSMC pits.

(16) 95th percentile UCL plus the change due to LTVSMC pits.

(17) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(18) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

St. Louis River at USGS #04024000
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
2016 Draft Antidegradation Conclusions and ProUCL results

							2016 Draft Antidegradation				ProUCL (Non-substitution methods)								
Parameter		Units	Applicable Standard[1]	Typical Reporting Limit (PQL)[2]	Number of Samples (n)	Percentage Non-Detect	2016 Draft Estimated Future Water Quality [3]	Existing Average Water Quality (substitution method)[4]	Upper LCS Limit[5]	Measurable Increase by LCS method?[6]	Alternative Estimated Future Water Quality [7]	Existing Water Quality Central Tendency[8]		95th Percentile UCL[9]	Estimated Change in Existing Central Tendency due to LTVSMC Pits [14]	Estimated Adjusted Central Tendency [15]	Estimated Adjusted 95th Percentile UCL [16]	Measurable Increase by UCL Method?[17]	LSC and UCL Measurable Increase Conclusion Same?
Aluminum (total)	Al	µg/L	125	2	50	2%	100	100	'--(18)	No	100.6		101	209	-0.41	100.6	208.6	No	Yes
Antimony (total)	Sb	µg/L	31	0.53	0		Not Available	Not Available	Not Available	Not Available	Not Available		Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Yes
Arsenic (total)	As	µg/L	53	0.5	67	34%	1.49	1.47	1.69	No	1.66		1.64	2.92	-0.001	1.64	2.92	No	Yes
Boron (total)	B	µg/L	500	100	91	0%	111	112	129	No	111		111	126	+0.09	112	126	No	Yes
Cadmium (total)	Cd	µg/L	2.5[10]	0.2	48	81%	1.36	1.36	1.56	No	1.00	<	1	1.67	-0.004	1.00	1.67	No	Yes
Chromium (total)	Cr	µg/L	11[10]	1	50	48%	6.42	6.4	7.36	No	6.25		6.26	10.8	-0.02	6.24	10.8	No	Yes
Cobalt (total)	Co	µg/L	5	0.2	52	96%	1.5	1.49	1.71	No	3.00	<	3	5	-0.01	2.99	4.99	No	Yes
Copper (total)	Cu	µg/L	9.3[10]	0.5	33	18%	7.53	7.5	8.63	No	7.44		7.44	22	-0.03	7.41	22.0	No	Yes
Lead (total)	Pb	µg/L	3.2[10]	0.5	34	79%	1.78	1.77	2.04	No	2.00	<	2	4	-0.01	1.99	3.99	No	Yes
Nickel (total)	Ni	µg/L	52[10]	0.5	39	56%	1.27	1.15	1.32	No	1.13	<	1	1.52	+0.01	1.01	1.53	No	Yes
Selenium (total)	Se	µg/L	5	1	73	96%	1	1	1.15	No	1.00	<	1	20	+0.001	1.00	20.0	No	Yes
Silver (total)	Ag	µg/L	1	0.2	53	98%	0.52	0.52	0.6	No	1.00	<	1	1	-0.004	1.00	1.00	No	Yes
Thallium (total)	Tl	µg/L	0.56	0.005	0		Not Available	Not Available	Not Available	Not Available	Not Available		Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Yes
Zinc (total)	Zn	µg/L	120[10]	6	55	18%	18.9	18.8	21.6	No	18.9		18.8	30.0	-0.06	18.7	29.9	No	Yes
Chloride	Cl	mg/L	230	5	387	0%	8.2	8.2	9	No	8.2		8.15	9.33	+0.08	8.2	9.4	No	Yes
Hardness (as $CaCO_3$)		mg/L	500	10	267	0%	78.7	80	92	No	78.5		76.7	78.8	+3.09	80	82	No	Yes
pH		SU	6.5 to 8.5	0.01	316	0%	Not Available	7.4	N/A	Not Available	Not Available		7.37	7.42	+0.004	7.38	7.42	Not Available	Yes
Solids, total dissolved[12]		mg/L	700	10	249	0%	Not Available	150	N/A	Not Available	Not Available		146	150	+3.82	150	154	Not Available	Yes
Specific Conductance @ 25°C[13]		µS/cm	1,000	0	319	0%	Not Available	189	N/A	Not Available	Not Available		183	188	+5.26	188	193	Not Available	Yes
Sulfate	SO_4	mg/L	none[11]	1	268	0%	19.1	19.7	21.7	No	19.5		18.1	18.3	+2.04	20.1	20.4	No	Yes

n.d. – All measured values are below reporting limits or the average value is below the reporting limit.

N/A -- The concept of LCS acceptance range does not apply for parameters that have existing concentrations below the reporting limit.

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Estimated future water quality estimated with mass balance calculations

(4) Average value of monitoring results, calculated using average values of duplicate samples and including results below analytic detection limits at half the value of the detection limit, and adjusted for flows from the LTVSMC pits that began after ther monitoring data was collected. (See Attachment E of the Antidegradation Evaluation for details)

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of the measured value. See Section 5.6 of Antidegradation

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6 of the Antidegradation Evaluation.

(7) Alternative future water quality estimated with mass balance calculations based on central tendency in column N

(8) Central Tendency determined as described in Table 1.

(9) 95% UCL determined as described in Table 2.

(10) Surface water quality standard is hardness dependent. The listed value assumes a hardness of 100 mg/L, which is the expected hardness of the WWTS discharge.

(11) The waterbody is not a listed wild rice water, so the sulfate standard of 10 mg/L for waters "used for production of wild rice" is not applicable.

(12) Total dissolved solids based on mass sum of anticipated dissolved water quality parameters in assumed WWTS discharge (Table 3-2) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis.

(13) Specific conductance reflects an electrical characteristic of the water and cannot be calculated from chemical water quality data for mixed salt solutions. Specific conductance was estimated from the overall assumed WWTS discharge quality (Table 3-2) using several empirical methods (Section 4.5.2.1) and adjusted for uncertainty based on monitoring data (Appendix A). The maximum projected water quality was used for the antidegradation analysis

(14) Changes to load and flow from LTVSMC pits estimated from water quality data as described in Attachment E.

(15) Existing water quality central tendency plus the change due to LTVSMC pits.

(16) 95th percentile UCL plus the change due to LTVSMC pits.

(17) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

(18) Measurable change was evaluated qualitatively because of the complex relationship between total and dissolved aluminum in Project area surface waters. See Section 6.3.4.2 of the Antidegradation Evaluation.

Mercury at all Stations
Existing and Estimated Mine Year 10 Water Quality in Receiving Waters
2016 Draft Antidegradation Evaluation and 95% UCLs

						2016 Draft Antidegradation				ProUCL (Non-substitution methods)		
Monitoring Station	Units	Applicable Standard[1]	Typical Reporting Limit (PQL)[2]	Number of Samples (n)	Percentage Non-Detect	Estimated Future Water Quality Mine Year 10 [3]	Existing Average Water Quality (KM mean)[4]	Upper LCS Limit[5]	Measurable Increase by LCS method?[6]	95th Percentile UCL[7]	Measurable Increase by UCL method?[8]	LSC and UCL Measurable Increase Conclusion Same?
MNSW12	ng/L	1.3	0.5	3	0%	4.7	4.7	5.7	No	9.5	No	Yes
MNSW8	ng/L	1.3	0.5	7	0%	4	4.0	4.9	No	5.6	No	Yes
PM-11	ng/L	1.3	0.5	38	16%	1.8	1.7	2.1	No	2.1	No	Yes
PM-13	ng/L	1.3	0.5	43	28%	3.4	3.4	4.2	No	4.2	No	Yes
SD026	ng/L	1.3	0.5	89	47%	1.3	0.6	0.7	Yes	0.7	Yes	Yes
SW004a	ng/L	1.3	0.5	19	0%	3.8	3.8	4.7	No	5.1	No	Yes
TC-1A	ng/L	1.3	0.5	12	0%	1.6	2.1	2.6	No	2.8	No	Yes
Forbes	ng/L	1.3	0.5	3	0%	4.1	4.1	5.1	No	8.9	No	Yes
Scanlon	ng/L	1.3	0.5	4	0%	4.6	4.6	5.7	No	9.4	No	Yes
Trimble Creek wetlands	ng/L	1.3	0.5	89	47%	1.3	2.1	2.6	No	2.8	No	Yes
Unnamed Creek Wetlands	ng/L	1.3	0.5	89	47%	1.3	1.7	2.1	No	2.1	No	Yes

(1) The most stringent applicable surface water quality standard; except, where a Minnesota Rule, chapter 7052 standard exists, it supersedes the Minnesota Rules, chapter 7050 standard(s), even if the Minnesota Rules, chapter 7052 standard is less stringent.

(2) The practical quantification limit (PQL), or reporting limit, is the lowest concentration that a laboratory can accurately measure (meeting US EPA criteria for laboratory accuracy and precision).

(3) Estimated using mass balance calculations

(4) Mean calculated using the Kaplan-Meier method

(5) Upper Laboratory Control Sample (LCS) limit is calculated from the existing average concentration, using the LCS acceptance criteria, which are a measure of the acceptable variability inherent in each EPA approved test method, expressed as a percentage of

(6) A measurable increase, using the LCS method, is defined as a value that is above the analytical reporting limit, and above the LCS acceptance range. See Section 5.6.

(8) 95% UCL determined as described in Table 2.

(9) A measurable increase, using the UCL method, is defined as a value that is above the analytical reporting limit, and above the 95% UCL.

Poly Met Mining, Inc. Groundwater Nondegradation Evaluation - Preliminary MPCA Determination

Overview

The MPCA staff has reviewed the potential effects on groundwater quality of the Poly Met Mining, Inc. (PolyMet), NorthMet Project (Project) proposal to mine and process ore for copper-nickel and platinum-group elements. The review considers the requirements set forth under Minnesota Rules Chapter 7060 to preserve and protect underground waters (groundwater) of the state by preventing any new pollution and abating existing pollution.

The Project site consists of three main areas: the Mine Site, Plant Site, and Transportation and Utility Corridors (see Large Figure 1, Vol. 1, NPDES/SDS Permit Application). The Plant Site is located approximately two miles north of the City of Hoyt Lakes in St. Louis County, Minnesota, on the former taconite processing facility and tailings basin previously operated by LTV Steel Mining Company (LTVSMC). The Mine Site is located approximately six miles from the Plant Site, south of the City of Babbitt in St. Louis County, Minnesota. The Transportation and Utility Corridors connect the Mine and Plant Sites. PolyMet proposes to conduct mining operations for 20 years and to generate approximately 308 million tons of waste rock, exclusively at the Mine Site. Following mining operations, activities related to site closure, reclamation, and water management would continue for a period of up to 50 years or longer, as needed, to achieve applicable water quality standards. The project underwent environmental review, culminating in a Final Environmental Impact Statement that the Minnesota DNR found adequate in 2016.

After careful review of the Project information, including modeling contained in the Final Environmental Impact Statement (FEIS), the MPCA staff has determined that due to a combination of controls and mitigation measures (such as engineering controls, wastewater treatment and water monitoring activities) that are part of the Project design, the proposed Project satisfies the requirements under Minnesota Rules 7060 for protection of groundwater resources.

Groundwater Protection

Because the Project has the potential to degrade groundwater through the leaching of metals, sulfate and other solutes from mining operations at the Mine Site and Plant Site locations, MPCA evaluated the potential impacts of the project according to its rules applicable to underground waters in Minnesota Rules chapter 7060. Minn. R. 7060.0200 states, in part:

> *"It is the policy of the MPCA to consider the actual or potential use of the groundwater of the state for its use as a potable water supply and to protect groundwater for this purpose for present and future generations…".*

Minn. R. 7060.0400 further states, in part:

> *"The waters of the state are classified according to their highest priority use, which for underground waters of suitable natural quality is their use now or in the future as a source of drinking, culinary, or food processing water…".*

Minn. R. 7050.0221 identifies the specific water quality standards for Class 1 waters of the state used for domestic consumption, including those applicable to groundwater. This rule states, in part:

Attachment 4 – Groundwater Nondegradation Evaluation

> "The class 1 standards in this part are the United States Environmental Protection Agency primary (maximum contaminant levels) and secondary drinking water standards..."

In addition to the primary maximum contaminant levels (MCLs) and secondary maximum contaminant levels (MCLs) promulgated by the EPA, the Minnesota Department of Health has adopted Health Risk Limits (HRLs) for drinking water. HRLs are not adopted as state water quality standards, but they reveal potential health risks to consumers of untreated groundwater. Not all parameters evaluated have applicable drinking water standards or HRLs.

Minn. R. 7060.0500 identifies a Nondegradation Policy applicable to underground waters of the state:

> *"It is the policy of the agency that the disposal of sewage, industrial waste, and other wastes shall be controlled as may be necessary to ensure that to the maximum practicable extent the underground waters of the state are maintained at their natural quality unless a determination is made by the agency that a change is justifiable by reason of necessary economic or social development and will not preclude appropriate beneficial present and future uses of the waters."*

These state rules for Underground Waters do not identify a specific review procedure or methodology that must be applied to demonstrate compliance with the nondegradation policy. Without a specific prescriptive approach in rule, this groundwater nondegradation analysis for the Project will focus on the engineering controls incorporated into the Project design, the resulting protection of the designated uses of groundwater, and the minimization of degradation of groundwater quality from its natural quality. This review focuses on Project activities that may affect the use of groundwater in the Embarrass and Partridge River watersheds downgradient of the Project as a source of drinking water, both now and into the future.

The potential effects of Project activities on surface water quality are addressed in the MPCA's antidegradation review of this Project (Poly Met Mining, Inc. Antidegradation Evaluation – Preliminary MPCA Determination).

<u>Mine Site</u>

The following is a general overview of groundwater flow at the Mine site. A more detailed description and analysis of the hydrogeological setting at the Mine Site can be found in Part C of Appendix A.

The Mine Site is located adjacent to a watershed divide with groundwater from the Mine Site flowing predominantly to the south towards the Partridge River and its tributaries (see Fig. 5.2.2-7, FEIS). The surficial groundwater at the Mine Site is of primary concern because of its shallow depth from the surface and its relatively high potential to transport solute contaminants within the surficial outwash and boulder deposits contained within due to their higher hydraulic conductivity. In contrast, the underlying fractured bedrock has a much lower hydraulic conductivity and is therefore less likely to be impacted by Project activities or to affect downgradient aquifers.

As discussed in Appendix A, surficial deposits in this area are relatively thin. This results in shorter surficial groundwater flow paths prior to groundwater discharge to downgradient surface waters. Although it is not a focus of this review, measures taken to protect the surficial groundwater will also have the effect of protecting the surface water to which it discharges.

Proposed mining operations at the Mine Site include the excavation and stockpiling of ore and the resultant surface mine pits. Mine Site activities with the potential to negatively affect groundwater quality include the mine pits, temporary and permanent waste rock and overburden stockpiles, ore storage or handling areas and mine water conveyance and storage features. As noted above, the leaching of metals, sulfate and other solutes from exposed waste rock, overburden, ore, wastewater ponds, and unsubmerged parts of the mine pit walls could impact mine site groundwater quality.

PolyMet has evaluated the potential for Mine Site activities to affect groundwater quality and has proposed engineering controls as part of the proposed Project to control waste materials and wastewaters to the maximum extent practicable, thereby minimizing potential sources of pollution to groundwater and to protect groundwater, as described below:

1. Permanent Category 1 Waste Rock Stockpile – a groundwater containment system will capture water infiltrating through the Category 1 stockpile and convey it to the Waste Water Treatment System (WWTS) for treatment. A geomembrane cover system will be placed incrementally over the waste rock as it is stockpiled, to reduce the infiltration of precipitation and waste loads to be captured and conveyed to the WWTS.
2. Temporary Category 2/3 and Category 4 Waste Rock Stockpiles and the Ore Surge Pile – engineered low-permeability composite liner systems will be installed beneath waste rock and ore stockpiles to capture stockpile drainage and prevent it from infiltrating downward to groundwater. Stockpile drainage will be collected and routed to the WWTS for treatment. The stockpiles will have operational lives between 11 to 21 years, after which they will be removed and their footprints reclaimed.
3. Overburden Storage and Laydown Area (OSLA) – will have a compacted base layer with low permeability and no separate engineered liner system. Runoff from the OSLA is expected to be of sufficient water quality so as not to require treatment beyond settling to remove suspended solids prior to pumping to the FTB. GoldSim modeling for the FEIS predicted that any infiltration through the compacted base of the OSLA would not adversely affect groundwater quality.
4. Equalization Basins – the Equalization Basins at the Mine Site will have engineered single geomembrane liner systems with a maximum 13-foot operating depth. The basins will be removed and reclaimed as part of the Mine Site reclamation process when they are no longer needed.
5. West Mine Pit – during operations this pit will be dewatered and groundwater will flow inwards towards the pit, thereby having no impact to groundwater quality during mining operations. After mining operations are completed, PolyMet will accelerate the natural flooding of this pit using treated water from the Plant Site WWTS (+/- untreated water from the FTB). As the West Pit fills, water from the pit will be pumped to the WWTS, treated and returned to the West Pit to manage the overall water quality of pit waters prior to groundwater outflow from the pit to the surficial aquifer. At about mine year 48, pit water levels will rise above the bedrock and flow into the surficial groundwater flow path towards the Partridge River. The flooding of the mine pit will control water quality by reducing the oxidation time for the pit wall rock and bringing contaminant constituent concentrations to their long-term steady state concentrations (see Table 5.2.2-20, FEIS).
6. East & Central Mine Pits – during operations the pits will be dewatered and groundwater will flow inwards, thereby having no impact to groundwater quality. After mining is completed, these pits will be backfilled with waste rock from the temporary waste rock stockpiles and from on-going mining in the West Pit and allowed to fill with water, to reduce oxidation in the waste rock and mine pit walls and reduce the potential for groundwater quality impacts. During flooding and for approximately 14 years after flooding is complete, PolyMet will recirculate and treat mine pit waters at the WWTS.

PolyMet has proposed to maintain these engineering controls and conduct groundwater quality monitoring for the duration of the mining operations and through future reclamation and closure activities, as long as necessary to meet groundwater standards (see Table 5.2.2-20 of the FEIS). This approach is consistent with the policy identified in Minn. R. 7060.0200 to protect and conserve groundwater supplies for present and future generations and the prevention of possible health hazards.

Groundwater Modeling Predictions

PolyMet conducted groundwater modeling simulations as part of the EIS process to predict the potential impacts of Mine Site Project activities on groundwater quality for a time period of 200 years from the start of mining operations.

Attachment 4 – Groundwater Nondegradation Evaluation

PolyMet used the GoldSim modeling platform to predict the concentrations of contaminants from mine operations at three downgradient locations: Dunka Road, the property boundary, and the Partridge River (see FEIS Fig. 5.2.2-7). The GoldSim modeling predictions provide the basis for understanding whether the Project activities are likely to be protective of groundwater quality, both now and into the future. The modeling included predictions for 27 solute contaminants that, based on host rock mineralogy and chemistry, had the potential to impact water resources.

PolyMet used the existing groundwater quality conditions as measured in on-site monitoring wells as inputs to the GoldSim modeling. Because the Mine Site does not have any existing development, the existing conditions represent natural background conditions as defined by Minn. R. 7060.0600 subp. 8. Where the natural state of groundwater exceeds state standards, the natural background is treated as the standard for drinking water. Minn. R. 7060.0600 subp. 8. This baseline monitoring indicated that the natural background concentrations of iron, aluminum and manganese exceed the water quality standards (defined by the secondary maximum contaminant levels) established for these parameters.

The GoldSim modeling predictions included both a "Continuation of Existing Conditions" scenario and a "Proposed Action" scenario that allowed a comparison of predicted project impacts against what conditions would be if the project was not built. The modeling predicts that during Project operations and after closure, Project activities would result in small increases in the groundwater concentrations for a limited number of solute contaminants compared to existing conditions. MPCA staff compared the predicted groundwater contaminant concentrations to the drinking water standards (accounting for natural background concentrations). The GoldSim modeling showed no exceedances of applicable drinking water standards or the HRLs as a result of the Project (see Table 5.2.2-23, Ch. 5, FEIS).

Based on MPCA review of the modeling results, PolyMet's proposed Project would not preclude beneficial present and future uses of the groundwater (7060.0500), nor would it cause exceedances of applicable drinking water standards. The Project would allow use of the groundwater as a potable water supply in accordance with 7060.0400. This conclusion is consistent with the findings of the MDNR-approved FEIS (Fig. 5.2.2-26).

<u>Existing Potable Water Supply</u>

Minnesota Rules relating to the nondegradation of groundwater do not directly address the protection of other waters that have a beneficial use as drinking water. However, as noted above, groundwater from the Mine Site enters the Partridge River and then flows to Colby Lake, which is the drinking water source for the City of Hoyt Lakes. To address the indirect effects that any groundwater impacts at the Mine Site activities could have on downstream waters, the GoldSim modeling included predictions of water quality in the Partridge River and Colby Lake. The evaluation determined that solute contaminant concentrations in Colby Lake as a result of the Project would essentially be the same as would occur if the Project were not built, and that concentrations in the lake would not exceed drinking water standards beyond what would occur if the Project did not happen. (FEIS Table 5.2.2-34). This evaluation found that the engineering controls proposed for the Mine Site are expected to protect not only groundwater at the Mine Site, and but also not to contribute to an exceedance in the potable water supply for the City of Hoyt Lakes in Colby Lake. This conclusion is consistent with the goal set forth in Minn. R. 7060 for protection of groundwater for its use as a potable water supply.

<u>Proposed Groundwater Monitoring</u>

The draft permit for the NorthMet Project includes a variety of groundwater monitoring of the surficial and bedrock aquifers at the Mine Site. This includes the continuation of monitoring at existing monitoring wells that were installed for the EIS (which include wells downgradient of proposed Mine Site facilities). New monitoring wells will be added to fill in gaps in the monitoring network, including at locations immediately downgradient of the Category 1 stockpile groundwater containment system. In general, groundwater quality will be monitored quarterly for key constituents (such as sulfate, chloride, copper and nickel) that can serve as "surrogates" for other parameters and annually for a wider range of parameters. The monitoring included in the draft permit is a combination of that recommended by the

FEIS, that proposed by PolyMet in the permit application, and that recommended by MPCA staff. The monitoring as proposed will be effective in verifying that groundwater resources are protected and that they will not be precluded from appropriate beneficial present and future uses.

Plant Site/Tailings Basin

Groundwater quality at the Plant Site/Tailings Basin (Plant Site) has been affected by seepage from the existing ferrous LTVSMC tailings basin. Only a small percentage of this seepage reaches the surficial aquifer; most ends up as shallow seepage that flows to wetlands and small tributaries north and west of the Plant Site that flow towards the Embarrass River (See FEIS Ch. 5, pp. 183-193).

The former LTVSMC tailings basin is currently a primary source of contaminants seeping to groundwater and surface water at the Plant Site. To eliminate this existing source and to minimize contributions from the NorthMet Project, PolyMet proposes to install a groundwater containment system to wrap around the Tailings Basin and capture both the shallow seepage to surface water and the deeper seepage to the aquifer. The containment system would include a low-permeability barrier down to bedrock to cut off surficial aquifer flow from the Tailings Basin. In addition, the system would maintain an inward water table gradient to prevent flow out of the system. Modeling of the containment system conducted as part of the FEIS indicated that little, if any, seepage would bypass the system through fractured bedrock. This is consistent with the information in Appendix A indicating that bedrock groundwater flow at the site, where it exists at all, is believed to be minor relative to surficial groundwater flow.

The seepage containment system, once constructed and operated, would immediately begin to intercept tailings basin seepage and remove it from the groundwater system for treatment at the WWTS. Following treatment at the WWTS, the treated water would be discharged to surface waters downgradient of the containment system; this would also have an immediate beneficial effect on downstream surface water quality. The effects on ground water quality, however, would lag behind those seen in the surface water because of the very slow velocity of groundwater flow relative to surface water flow. In other words, it will take a much longer period of time before the improvements in ground water quality are able to be measured in the monitoring wells located at the property boundary.

Captured seepage would be treated in the WWTS or re-used in Plant Site processing. PolyMet has also proposed additional engineering controls to reduce the potential for seepage through the unlined Tailings Basin that includes the installation of bentonite amendments to the tailings dams, Tailings Basin beaches and pond bottom. These combined engineering controls would abate existing pollution, maximize the possibility of rehabilitating the existing degraded groundwater, and minimize longer term effects to groundwater quality in accordance with the policies set forth in Minnesota Rule 7060.0400.

Groundwater Modeling Predictions

As part of the completed EIS process, PolyMet evaluated the potential impacts of Project activities at the Plant Site on groundwater quality using GoldSim, modeling from the Plant Site to the property boundary (see Fig. 5.2.2-9). As with the Mine Site, the GoldSim modeling for the Plant Site compares the potential Project activity effects on groundwater quality to drinking water standards as well as to a continuation of existing conditions scenario where no Project activity takes place. MPCA staff reviewed the GoldSim modeling predictions for contaminant impacts to groundwater and found that, in general, the concentration of groundwater contaminants with the Project would remain the same or decrease over time, and would be lower than concentrations that would occur if the project was not built. The GoldSim modeling predictions indicate that the Project would not cause exceedances of drinking water standards beyond what would occur with no Project activities. This indicates PolyMet's proposed Project actions at the Plant Site would not preclude appropriate beneficial present and future uses of the groundwater beyond what would occur if the Project was not constructed, in accordance with Minnesota Rule 7060.0500, Nondegradation Policy.

Attachment 4 – Groundwater Nondegradation Evaluation

Proposed Groundwater Monitoring

The draft permit for the NorthMet Project includes groundwater monitoring of the surficial and bedrock aquifers downgradient of the Tailings Basin. This includes the continuation of monitoring at existing monitoring wells near the property boundary and at new monitoring wells to be located just downgradient of the seepage containment system. In general, groundwater quality will be monitored quarterly for key constituents (such as sulfate, chloride, copper and nickel that can serve as surrogates for other parameters) and annually for a wider range of parameters. The monitoring included in the draft permit is a combination of that recommended by the FEIS, that proposed by PolyMet in the permit application and that deemed advisable by MPCA staff. The monitoring as proposed will be effective in verifying that groundwater resources are protected and that they will not be precluded from appropriate beneficial present and future uses.

Summary

PolyMet has proposed a combination of engineering controls and wastewater treatment that are protective of groundwater quality for the proposed Project. PolyMet has also conducted GoldSim modeling simulations that predict the effects of Project activities on groundwater quality; which indicate the Project will not cause exceedances of relevant groundwater quality standards, beyond what would occur if the Project was not constructed. Furthermore, PolyMet has proposed to monitor for potential impacts from Project activities on a recurring basis throughout operations, reclamation, and closure to ensure the protection of groundwater and surface water quality. (Chapter 5, FEIS, pp. 5-8, 9).

Based on a careful review of the Project information listed below, the MPCA staff have determined the proposed PolyMet Project satisfies the requirements set forth under Minnesota Rules 7060 for protection of groundwater resources. The proposed groundwater monitoring included in the NPDES/SDS permit will verify the protection of the groundwater resources.

1. PolyMet NPDES/SDS Permit Application to the MPCA, October 2017 (NPDES/SDS Permit Application). https://www.pca.state.mn.us/quick-links/water-quality-permit-northmet,
2. Final Environmental Impact Statement (FEIS). http://www.dnr.state.mn.us/input/environmentalreview/polymet/feis-toc.html,
3. Poly Met Mining, Inc. Antidegradation Evaluation – Preliminary MPCA Determination
4. Groundwater Concentrations Time Series Analysis, Excel Spreadsheet, Mine Site Version 6.0. Package Volume 2, and
5. Groundwater Concentrations Time Series Analysis, Excel Spreadsheet, Plant Site Version 6.0. Package Volume 2.

APPENDIX A

Poly Met Mining, Inc. Groundwater Nondegradation Analysis - Preliminary MPCA Determination

A. Summary

This report addresses a part of the NPDES/SDS application from the Poly Met Mining, Inc. (PolyMet) for the NorthMet project (Project), which focuses on the potential for contamination of groundwater that could occur from mining, processing and waste disposal activities associated with the Project. Groundwater staff have conducted this review by incorporating elements of the surface water anti-degradation review process, and employing methods commonly employed in various MPCA hydrogeologic investigations. Surface water is protected under antidegradation language in Minnesota Rule 7050 (1), while groundwater is similarly protected under nondegradation language in Minnesota Rule 7060 (2).

This report will provide the reader with a technical overview of the hydrogeology of the PolyMet project area, as well as a review of the groundwater issues raised in the NPDES/SDS permit application directed toward groundwater, using the standard provided on nondegradation in Minnesota Rule 7060.0500. The report concludes with recommendations on potential additional placement of new well(s) in areas not currently monitored. These are areas with preferential groundwater pathways leading from Project facilities to surface water discharge points. Surface water is an important factor in this analysis because the groundwater flowpaths in the project area are short in length, not used as a source of drinking water supplies, and end in nearby streams. This report also recommends methods for identifying when the detection of rising contaminant concentrations in future monitoring data from compliance wells could indicate a potential failure of the engineering systems proposed by PolyMet such that adaptive management or mitigation should be required.

<u>Report assumptions</u>

This report is based on two key assumptions. First, the report concerns itself primarily with the hydrogeology of the site, and not the engineering details that are part of the PolyMet mine process. The report emphasizes the surface water and groundwater watershed boundaries, surficial geologic properties and thicknesses, bedrock geology, presence of geologic contacts and faults, and other issues. This groundwater review will be responsive to questions specifically addressing groundwater issues, as well as individual surface water issues that warrant a groundwater response. Therefore, the applicable standard of review is whether underground waters of the state are maintained at their natural quality to the maximum practicable extent.

The second assumption is that the technical aspects of the report are based on a careful review of the technical resources available to the author through publically accessible datasets and maps. Sources include the Minnesota Geological Survey (MGS), Minnesota Department of Natural Resources, the MPCA, Minnesota Geospatial Commons, and others. It is assumed that the information gathered for this review includes all relevant information available at the time this report was prepared. References to all sources are provided in the references at the end of this report.

B. Background

PolyMet is proposing to develop a mine and associated processing facilities for the extraction of copper, nickel, and platinum group elements (PGE) in northeastern Minnesota. The mine would be the first of its kind in the state. The proposed mining project would be located in the St. Louis River watershed on the eastern edge of the Mesabi Iron Range, about 6 miles south of Babbitt. On July 11, 2016, PolyMet submitted an application to the MPCA for an NPDES/SDS water quality permit for the NorthMet project. The information contained in the permit application is used by the MPCA to determine which state and federal requirements apply. The MPCA reviews the application to determine if it contains all of the information necessary to start processing the application, to ensure the project can meet applicable laws and requirements and preparing a draft permit for public input.

The references in the PolyMet application focused on groundwater can be found in the complete PolyMet NPDES/SDS permit application (6). Within the following volumes are sections devoted to the potential threat to groundwater:

<u>Volume 2 – Mine Site: Section 4.0</u>

The State of Minnesota has a nondegradation policy to protect groundwater in Minnesota Rules, part 7060.0500, (2):

> It is the policy of the agency that the disposal of sewage, industrial waste, and other wastes shall be controlled as may be necessary to ensure that to the maximum practicable extent the underground waters of the state are maintained at their natural quality unless a determination is made by the agency that a change is justifiable by reason of necessary economic or social development and will not preclude appropriate beneficial present and future uses of the waters.

PolyMet's response to 7060.0500 for the Mine site from Volume 2, page 45:

> The available sampling results, as summarized in Section 3.1.2 of this volume, establish that the groundwater at the Mine Site remains in its natural quality. There are no known existing or previous discharges from human activities in the immediate vicinity of the Mine Site, and Mine Site water quality is similar to regional data (Section 4.3.4.1.4 of Reference (4)). Because the Mine Site groundwater remains at its natural quality, PolyMet has designed the Project to comply with the State's groundwater nondegradation policy, including the "maximum practicable extent" requirements of Minnesota Rules, parts 7060.0500 and .0600.

In its application, PolyMet expresses its confidence that groundwater quality will not be degraded by mining activities, due to the use of engineering controls at the Mine Site. PolyMet has committed to keep the concentrations of relevant parameters at or below current, pre-mining levels. Monitoring wells would confirm that the controls are working to their expected specifications. However, the determination of what increase of concentrations of specific parameters would constitute a failure of the engineering systems, and therefore a release of contamination into groundwater, has not been explicitly identified by PolyMet. Therefore, to determine whether there has been a degradation of groundwater, MPCA staff recommend use of a technical process described near the end of this report, designed to identify when a statistically significant change in parameter concentrations has occurred when compared to initial concentrations. If a (increasing) change is statistically significant, it would then indicate a potential failure of engineering controls, and a failure of the effort to avoid nondegradation of groundwater.

<u>Volume 5 – Tailings Basin & Beneficiation Plant: Section 4.0</u>

The PolyMet discussion of nondegradation in the area downgradient of the Tailings Basin starts out in the same fashion as the response to potential Mine site degradation, by referencing Minnesota Rules. However, the conditions at the Tailings Basin located in the Embarrass River watershed, differ from the Mine Site in that the existing water quality downgradient of the Tailing Basin is degraded due to past iron mining activities at the site. From the PolyMet application, Volume 5, page 38:

> Downgradient of the LTVSMC tailings basin, groundwater does not exist in its natural condition, as a result of seepage of pollutants from decades of ferrous mining activities at the site, including in particular ferrous seepage from the LTVSMC tailings basin.......... Where groundwater in its "natural condition" is not present to be protected against degradation, the State's groundwater policy focuses instead on "abating [existing] pollution" and "maximiz[ing] the possibility of rehabilitating degraded waters."(Minnesota Rules, part 7060.0400). The Project's design will have the effect of rehabilitating currently degraded groundwater downgradient of the Tailings Basin in accordance with the policies set forth in Minnesota Rules, chapter 7060 (Section 4.3).

The area downgradient of the legacy iron tailings basin has elevated levels of certain parameters including chloride, sulfate, other major cations and anions, fluoride and molybdenum. (7) PolyMet states on page 38, that:

> Downgradient of the LTVSMC tailings basin, groundwater does not exist in its natural condition, as a result of seepage of pollutants from decades of ferrous mining activities at the site, including in particular ferrous seepage from the LTVSMC tailings basin.

In its application PolyMet states that the engineering controls employed to abate the existing flow of ferrous seepage to groundwater will eventually improve the groundwater quality in the area. PolyMet will monitor paired wells that straddle the new Tailings Basin boundary, to ensure that groundwater flow remains inward, toward the basin. PolyMet states in Section 4.3 of Vol 5, page 39, that:

> PolyMet will monitor the performance of the FTB seepage capture systems and the groundwater quality downgradient of the Tailings Basin (Section 3.2.2 of Volume I), and if the engineering controls are not achieving the desired outcomes, will implement adaptive management actions or contingency mitigation (Sections 6.5 and 6.6 of Reference (1)), as necessary to comply with all permit conditions.

Given this expectation, a statistical method such as the one referenced earlier in the Mine Site section, and fully described near the end of this report could also be applied to the Tailings Basin area. As with the Mine Site, PolyMet is pledging to keep the concentrations of relevant parameters at or below current levels. In the case that concentrations of parameters of concern are reduced as PolyMet predicts, there would be no need to determine a statistical difference from initial conditions, because groundwater is not being degraded. However, were concentrations to have increased to a level that is determined to be statistically significant when compared to pre-PolyMet mining levels, then groundwater degradation will be identified.

<u>Volume 6 – HRF & Hydrometallurgical Plant: Section 4.0</u>

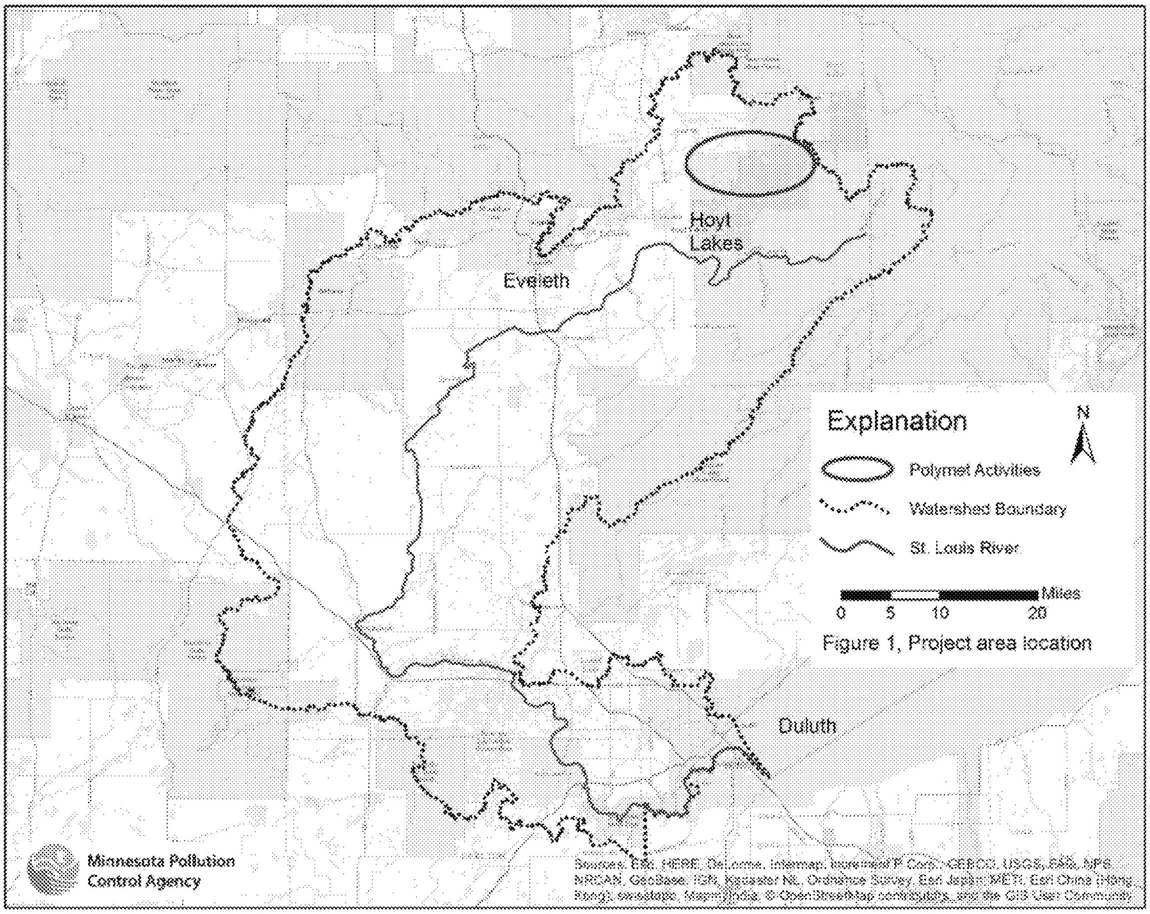
The PolyMet discussion of groundwater nondegradation downgradient of the Hydrometallurgical Residue Facility (HRF) is similar to the approach taken for Volume 5, for the Tailings Basin. Volume 6 states:

> ....groundwater downgradient of the HRF has been discernably impacted by previous ferrous mining activities and does not reflect natural quality.

Therefore, the Agency approach to identifying a release of contaminated groundwater that would constitute a failure of engineering controls for the HRF and Hydrometallurgical Plant will be the same as for groundwater downgradient of the Tailings Basin.

C. Hydrogeological Setting of the PolyMet Site

<u>Project Area Location</u>



The PolyMet site is located south of the city of Babbitt and north of the city of Hoyt Lakes in St. Louis County, Minnesota (Figure 1). The site is located in the upper St. Louis River Watershed.

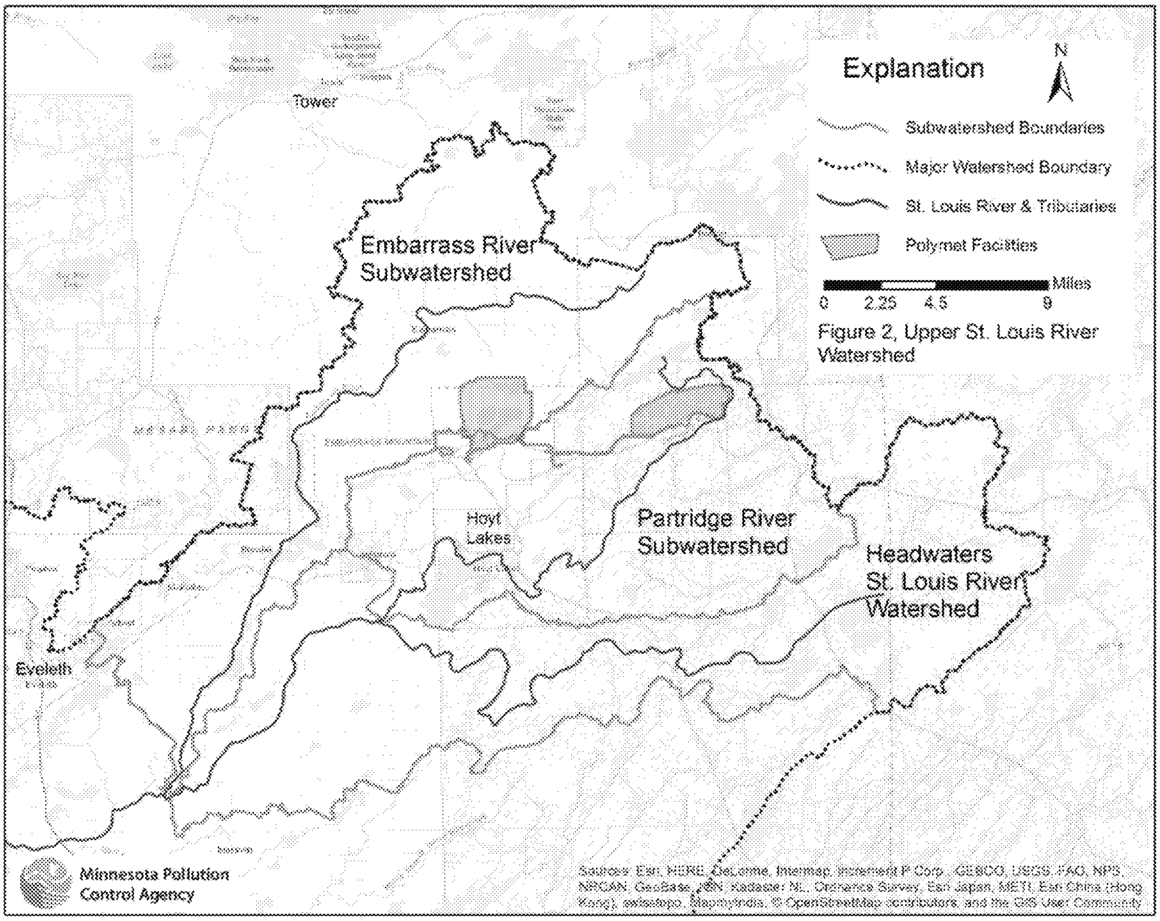


Figure 2, Upper St. Louis River Watershed

The St. Louis River flows 192 miles down more than 1,000 feet of elevation before reaching Duluth and Lake Superior. Figure 2 shows a close-up of the upper watershed, with the three subwatersheds closest to the PolyMet site: the Embarrass, the Partridge, and the St. Louis River Headwaters.

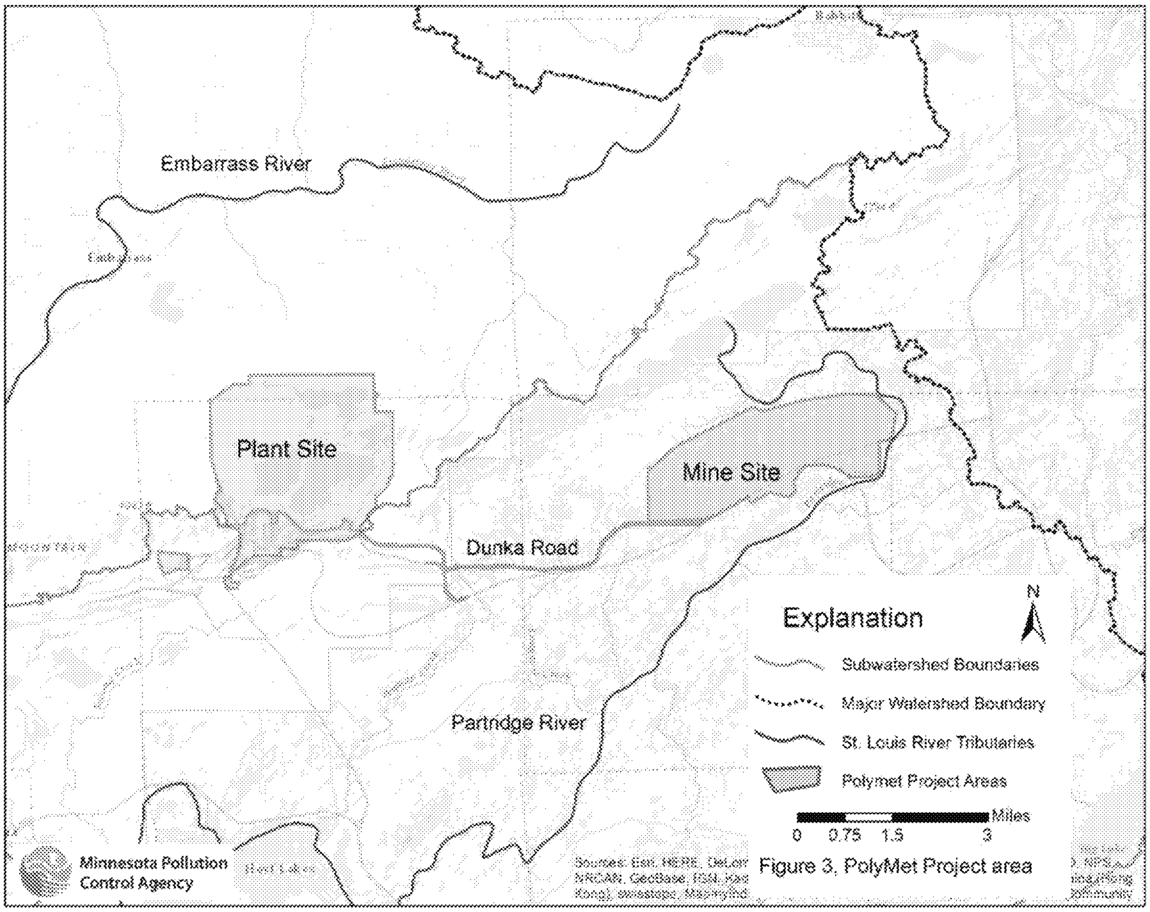


Figure 3, PolyMet Project area

All surface water flow in these subwatersheds is to the St. Louis River. Figure 3 shows the outlines and locations of the PolyMet proposed sites, including the Plant Site, the Mine Site, and the road connection between them (9).

The Mine Site is located in the upper Partridge River watershed in very close proximity to the river. The Plant Site is located on the boundary separating the Partridge from the Embarrass watersheds, with most of the Tailings Basin in the Embarrass River watershed and the Process area in the Partridge River watershed.

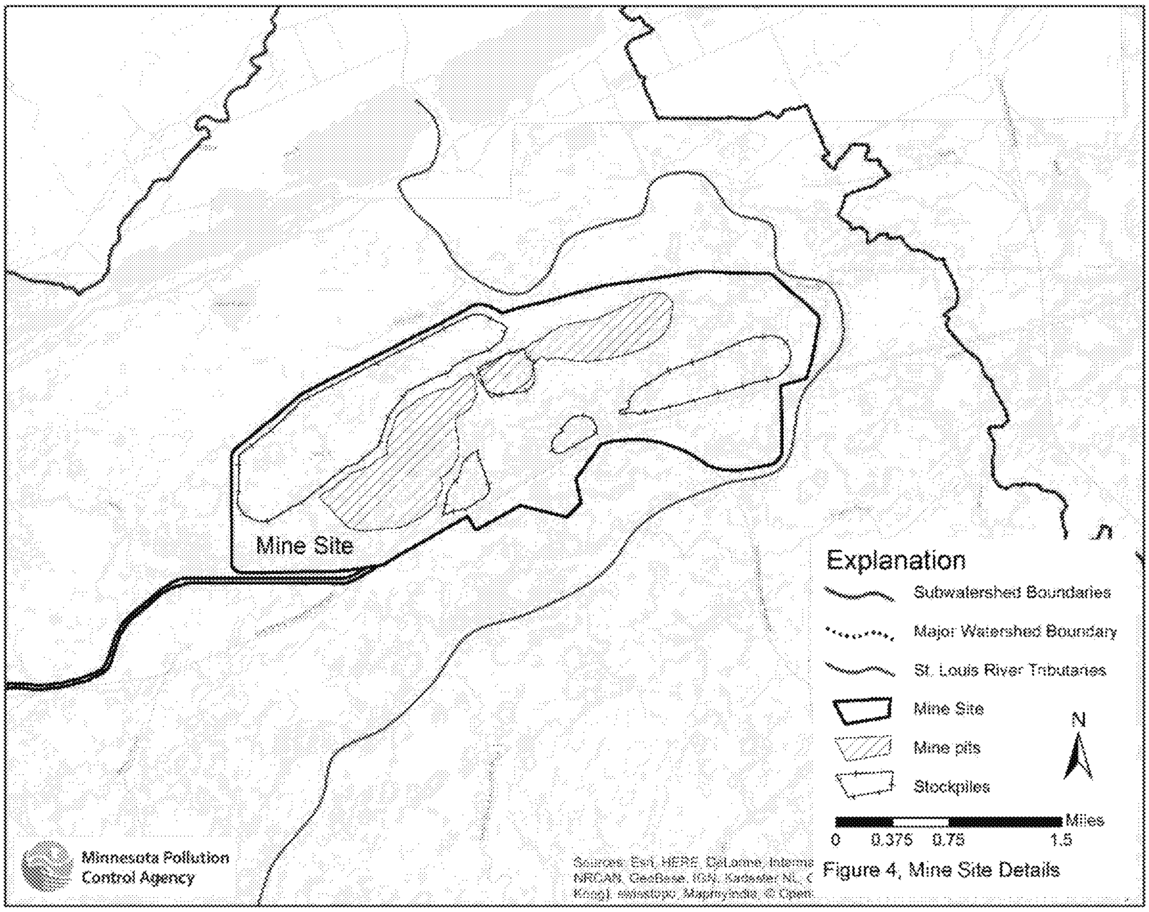


Figure 4, Mine Site Details

Figure 4 provides a close-up of the Mine Site shown in the previous figure. Within the outline of the Mine Site are polygons showing the location of the three mine pits (west, central, and east) and the stockpiles.

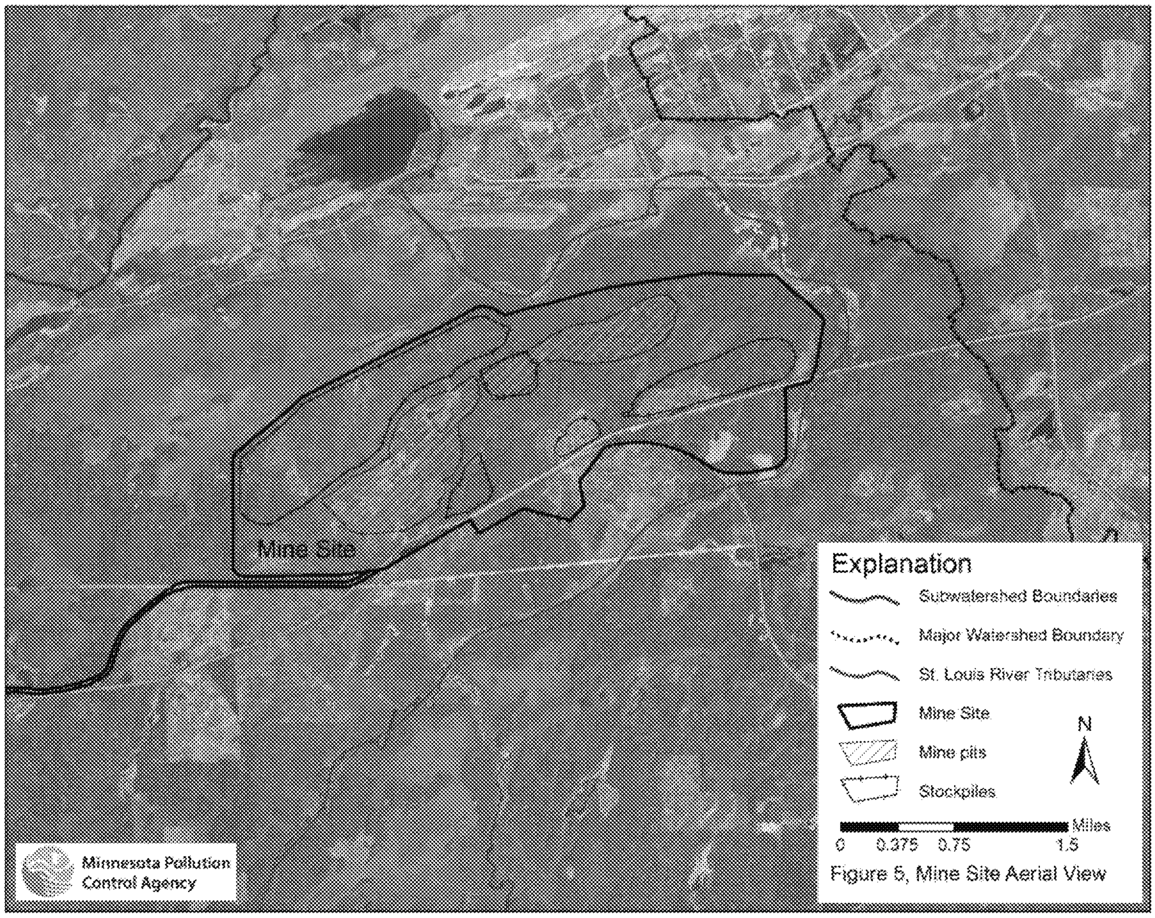


Figure 5, Mine Site Aerial View

Figure 5 is identical to Figure 4, except now with an aerial photograph as background. This reveals the undeveloped nature of the Mine Site in contrast to the active Peter Mitchell iron mine to the north.

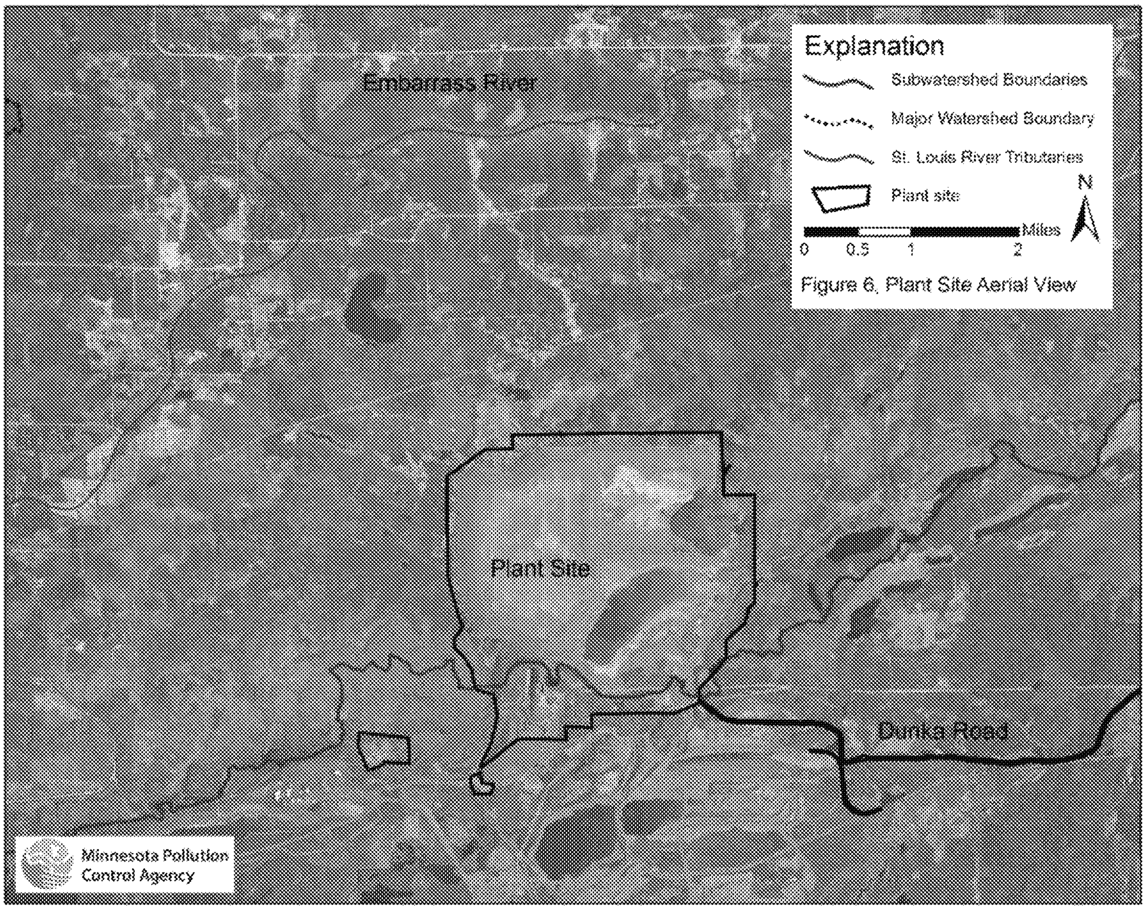


Figure 6 shows the Plant Site with an aerial photograph as background. The Plant Site is disturbed ground that served both as a process area and tailings basin for past iron mining.

Project Area Geomorphology

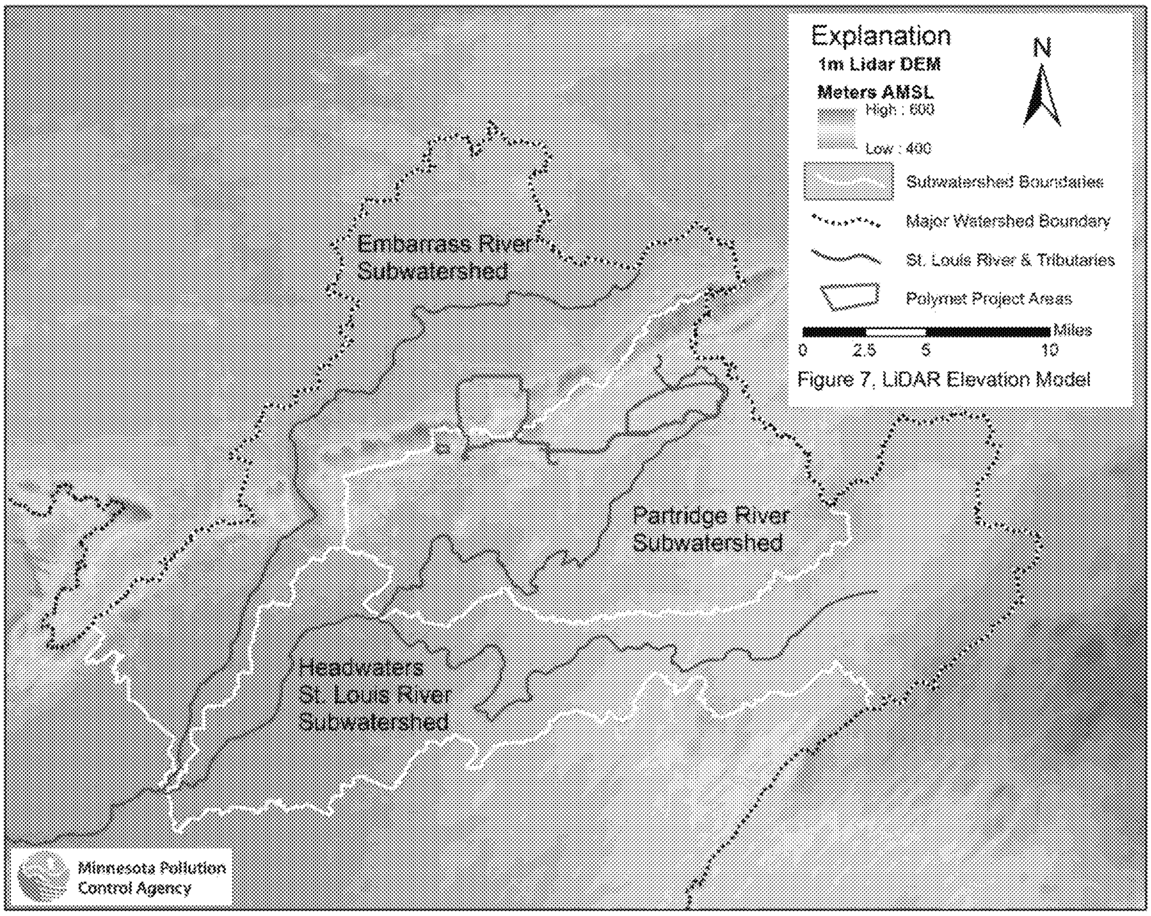


Figure 7. LiDAR Elevation Model

Figure 7 shows the upper watershed with a background of a land surface digital elevation model produced from LiDAR, which stands for Light Detection and Ranging, providing a highly detailed and accurate elevation-based map. Hot colors (dark oranges) are highest elevations and cool colors (dark green) are lowest. Elevations in the area range from approximately 2,000 to 1,300 feet above mean sea level. The highly visible boundary between the Partridge and the Embarrass watersheds is a feature known locally as the Embarrass Mountains, a ridge dominated by granitic bedrock outcrops.

Both the Mining and Plant sites are located along the highest reaches of their respective watersheds, and are located in close proximity to the rivers that define the subwatersheds.

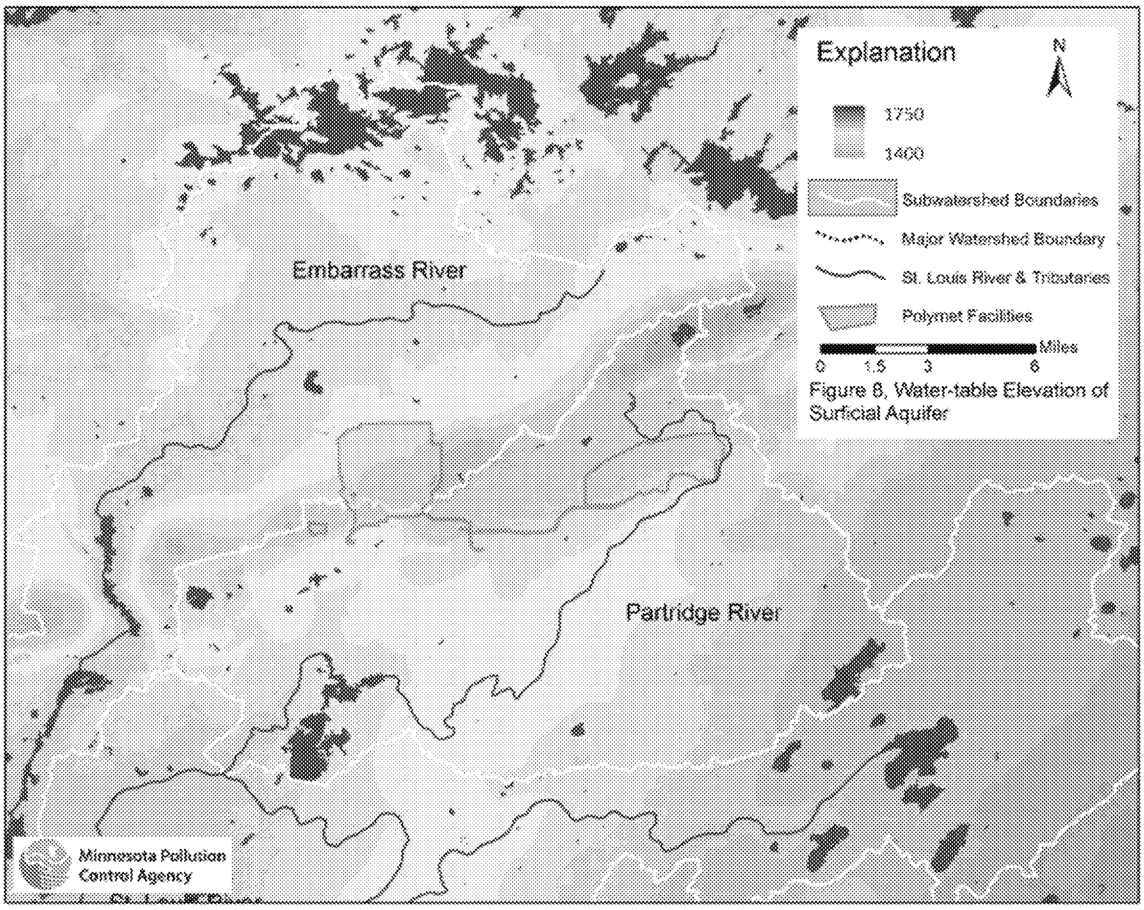


Figure 8, Water-table Elevation of Surficial Aquifer

Figure 8 displays the surficial water table, and strongly resembles the previous figure with hot colors representing higher elevations, and cool colors lower elevations. The MN DNR developed this statewide map of water table elevations, and in areas such as this where groundwater information is sparse and bedrock is close to the surface, the map works off the assumption that the water table is strongly influenced by the topography, or surface elevation. This will be discussed further in this report, but indicates that the groundwater shed and the surface water watershed have similar boundaries in portions of the watersheds.

An important observation to mark from this map is that groundwater in the surficial aquifer near the Plant and Mine sites flows away from the watershed boundaries, across the PolyMet sites, and toward the St. Louis River tributaries.

Project Area Surficial Geology

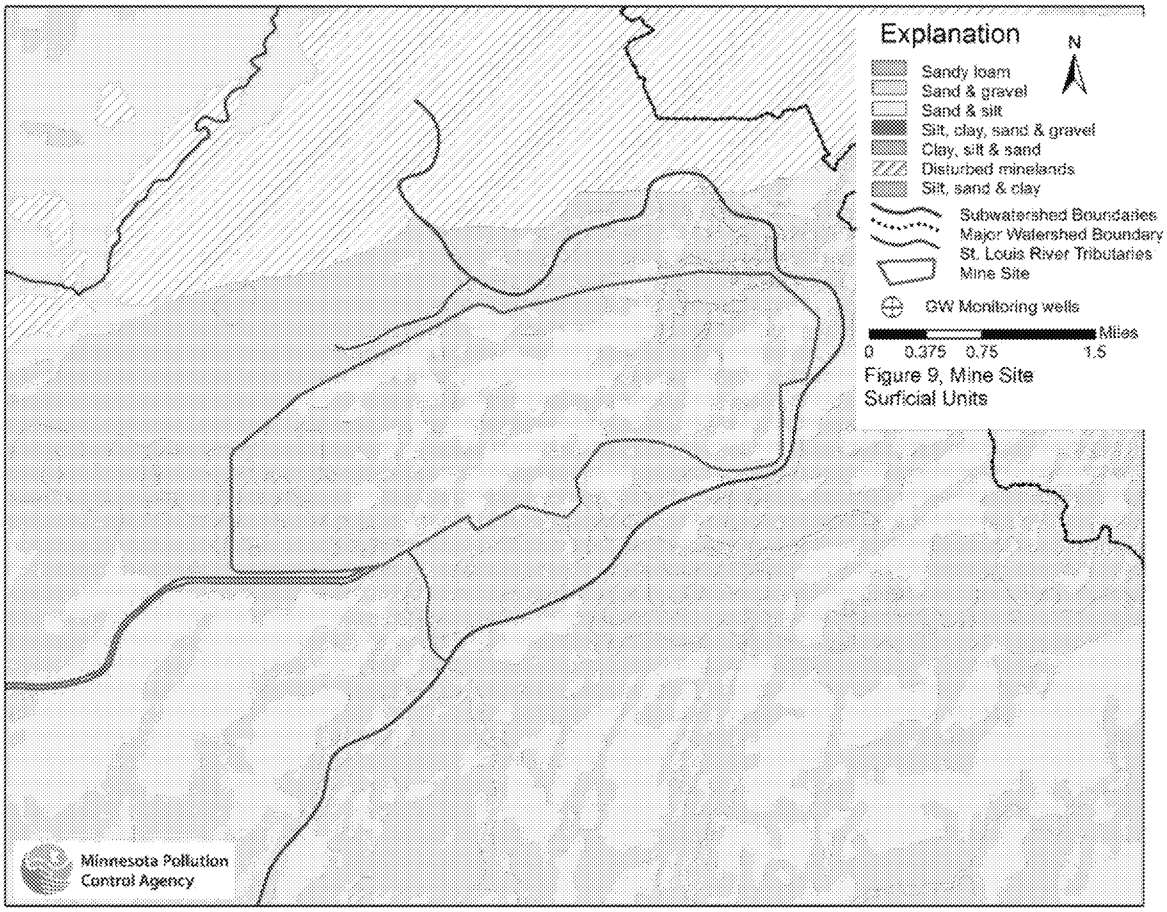


Figure 9 is a map of the surficial geology of the Mine Site. This geologic information is the product of the MGS, and is the first completed mapping of the St. Louis & Lake Counties Geologic Atlas (10). This is a simplified interpretation of the MGS surficial geology map, with sand-dominated and clay-dominated units grouped together. Geologic units dominated by sand are found along the southern boundary of the Mine site, while clay-dominated units are found to the north, in the upper watershed.

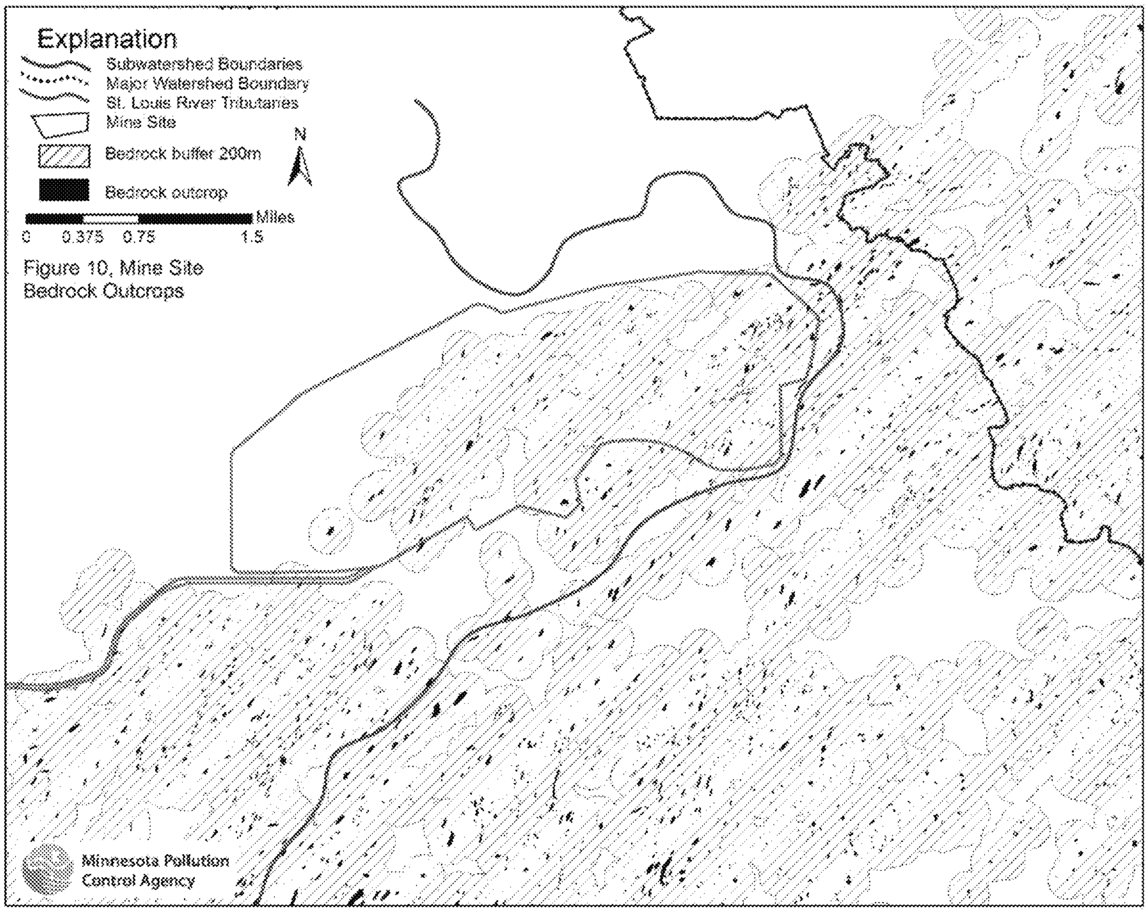


Figure 10, Mine Site Bedrock Outcrops

Figure 10 is a display of the Mine Site against a backdrop of a combination bedrock outcrop and depth-to-bedrock map. The MGS surface geology plate's map symbols key states that the bedrock outcrop and buffer patterns both delineate:

> ………regions where bedrock occurs at the surface, as well as where the overlying units are thin (less than ten feet) to bedrock. This was created by using the outcrop database and setting a buffer of 656 feet (200 meters) around each outcrop. Though this buffer is fairly accurate, the actual bedrock topography is extremely variable in this region. There will likely be areas covered by the shading that are greater than ten feet to bedrock, and locations that are less than ten feet to bedrock not covered by the shading.

The thickness of the surficial geology is important because thinner material generally means shorter and faster flow paths as groundwater is restricted to the near surface as it moves to discharge to the tributary streams. Bedrock is at or near the surface throughout the area between the south boundary of the Mine Site and the Partridge River.

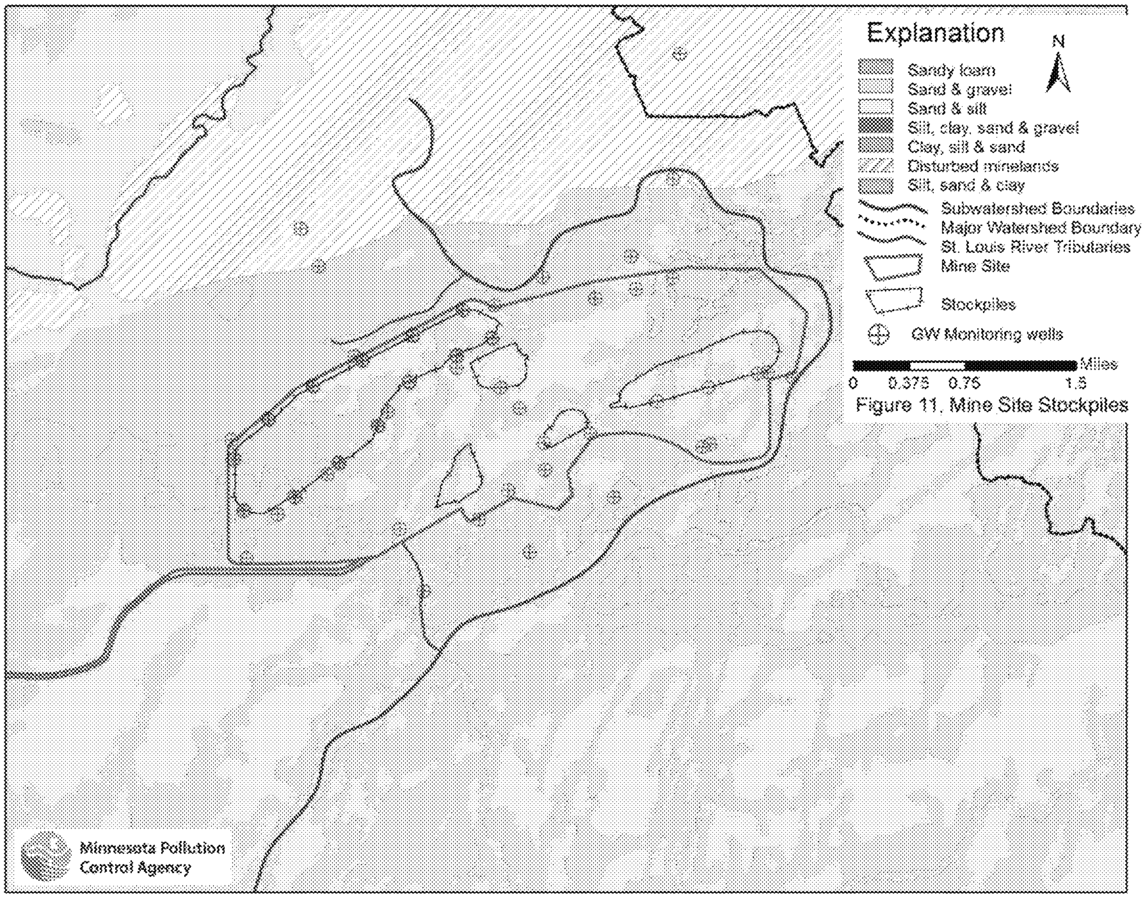


Figure 11. Mine Site Stockpiles

Figure 11 adds all surficial monitoring wells and the outlines of the stockpiles at the Mine Site. The majority of the stockpiles (with the exception of the Category 1 waste rock stockpile in the northwest of the Mine Site) are temporary, to remain in place for 11 – 21 years, and then consolidated into one of the mine pits before the mine closure.

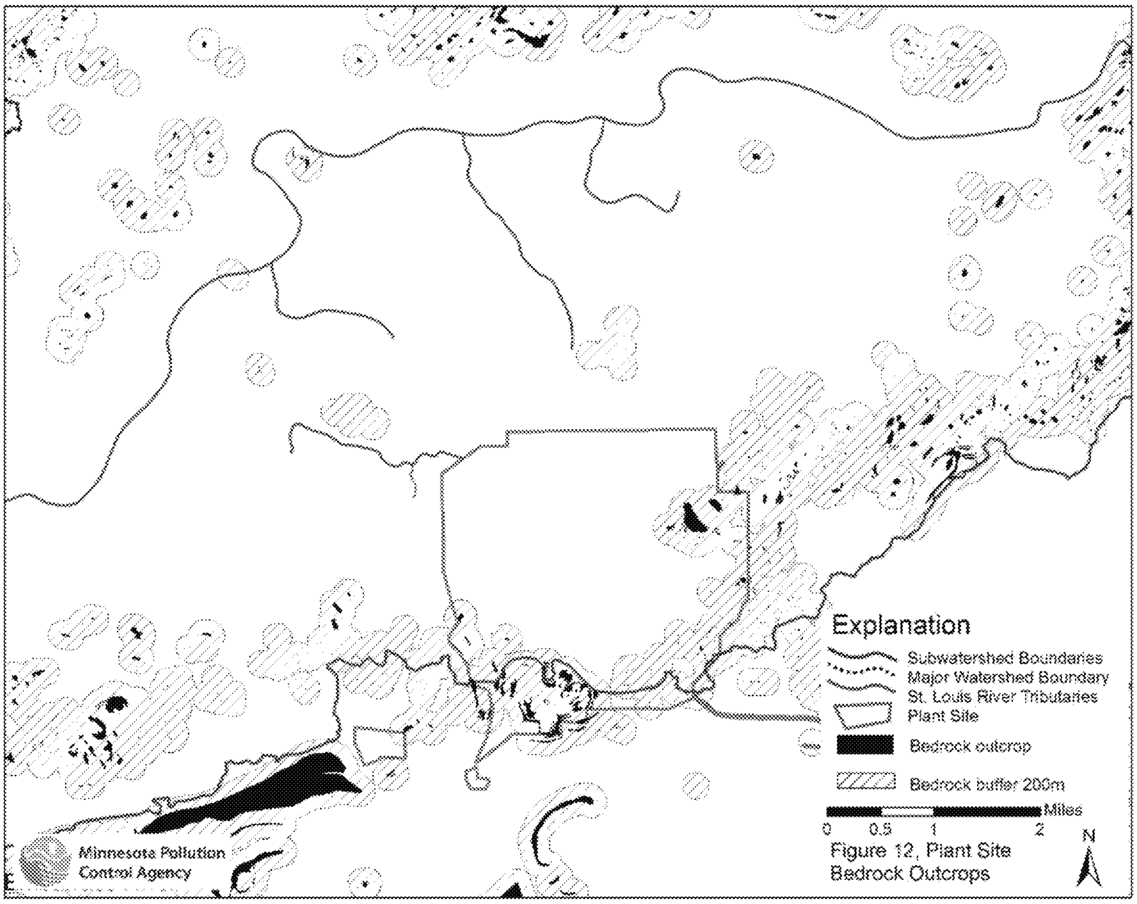


Figure 12, Plant Site Bedrock Outcrops

Turning to the Plant site, Figure 12 shows the bedrock outcrop and buffer analyses for the area. Bedrock and shallow surficial material can be found along the watershed boundary that divides the Plant site from the Tailings Basin. From this map it is clear that the thickness of surficial geologic material increases to more than 10 feet north and west of the tailings basin, in the downgradient groundwater flow direction toward the Embarrass River.

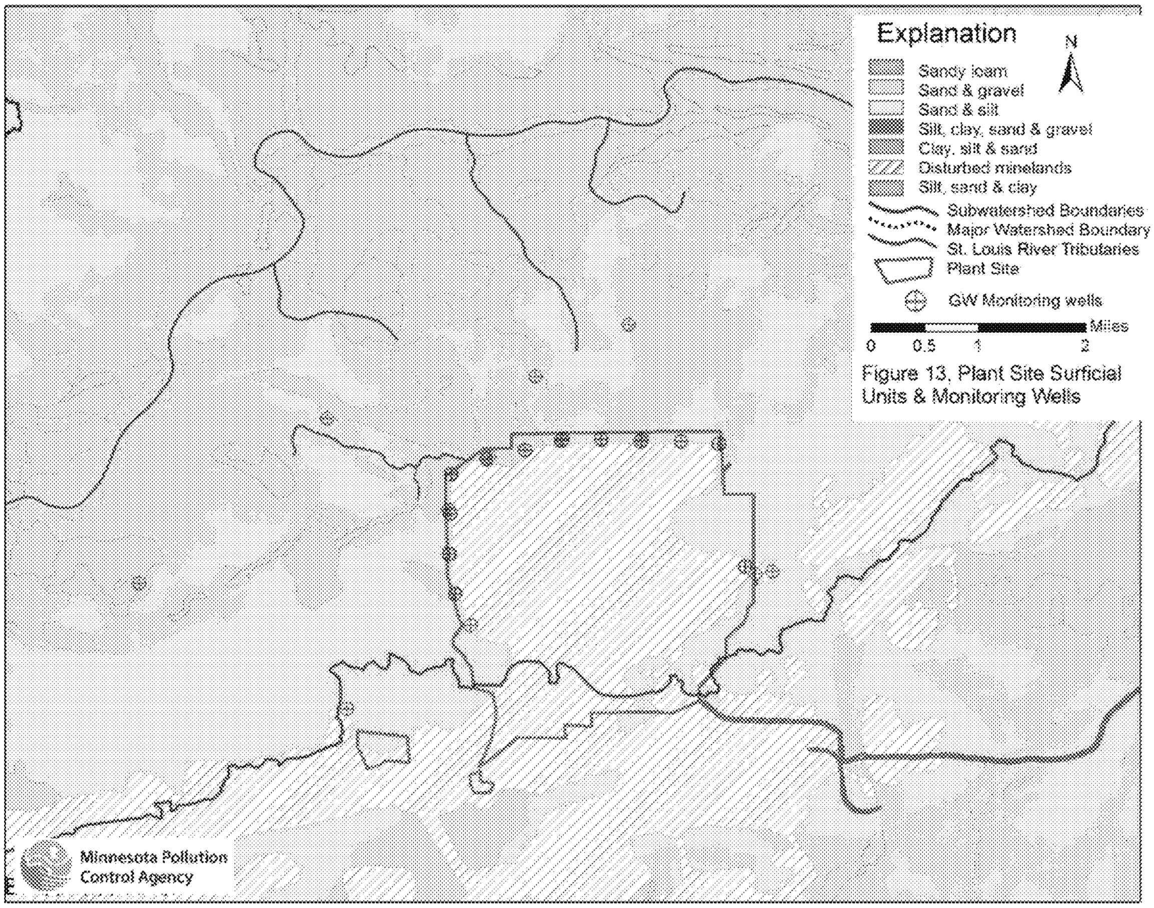


Figure 13. Plant Site Surficial Units & Monitoring Wells

The Plant site surficial geology, with monitoring wells is displayed as Figure 13. Much of the tailings basin area has been extensively disturbed by past mining activity.

Project Area Bedrock Geology

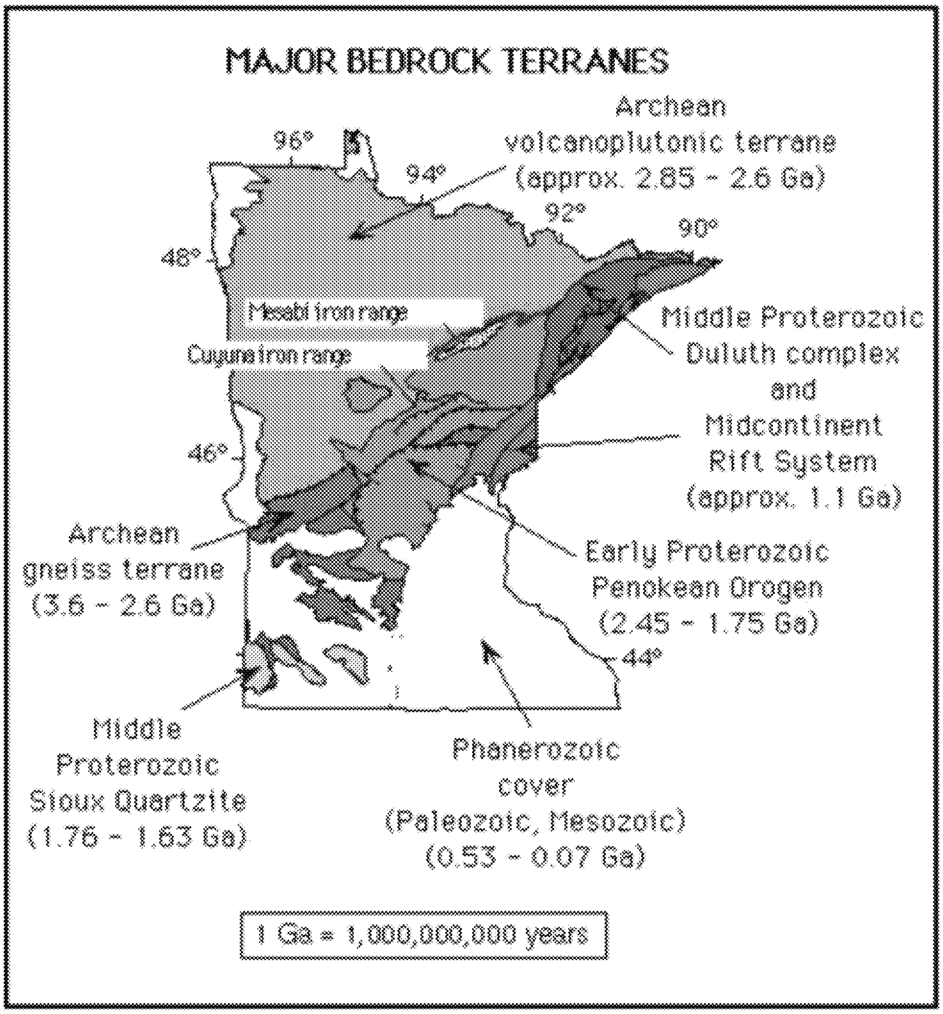


Figure 14, Minnesota's Bedrock Regions (11)

The bedrock underlying the PolyMet site is a very different geologic environment from the overlying surficial material. Where the surficial geology is the product of glaciation that occurred less than 10,000 years ago, the bedrock is over 1 billion years old. (Figure 14).

The Duluth Complex and the associated North Shore Volcanic Group are rock formations that comprise much of the basement bedrock of the northeastern part of Minnesota. Both formations are igneous rocks formed during the Midcontinent Rift. The Duluth Complex is a composite intrusion of troctolite and gabbro derived from periodic tapping of an evolving magma source. This rock is dense, and in the region of the PolyMet project area it has near-surface fracturing. These fractures are not mapped, and their hydrologic properties are little understood. From personal communication with one of the MGS report authors:

> ..... the nature of faults and other fractures in bedrock is poorly known. The only "ground truth" are the joint measurements we made on outcrops, but that data set was not released with the open-file report. Even with those data, establishing depth of penetration and interconnectedness of fractures is nearly impossible to establish without very precise and detailed (site-specific) information. It is generally logical to infer that joint spacing and connectedness decreases with depth .... In the end, the only absolute way to assess continuity

of fractures is to drill patterns of holes so closely spaced that the rock is turned to swiss cheese. Adding complexity to these questions is literature that reports deeply weathered faults and fractures that were altered to clay minerals (saprolite) can actually behave as aquitards.

Though little is known about groundwater flow through the bedrock, it is assumed to be limited by the narrow fractures and the potential for infilling by low transmissive materials. Because of this poorly understood fracture-based porosity, the decision was made by PolyMet to initially install wells only in the overlying surficial geologic material. (Some of the wells identified as bedrock wells in the project report are actually screened above the bedrock/surficial material interface.) This can be a successful strategy because bedrock flow in this area is often strongly influenced by the flow in the overlying surficial materials. As discussed previously in this report about groundwater flow in the surficial material, this would lead to the conclusion that the best assumption of groundwater flow behavior in the bedrock is that it mimics flow directions in the surficial unit. Combined with the previous discussion about the lack of surficial material along much of the Embarrass and Partridge watershed boundary, groundwater flow in the bedrock system is assumed to be constrained by surface water watershed boundaries. To clarify, that means that it is assumed in this report that groundwater that is found in one watershed will remain in that watershed through to discharge to the watershed river.

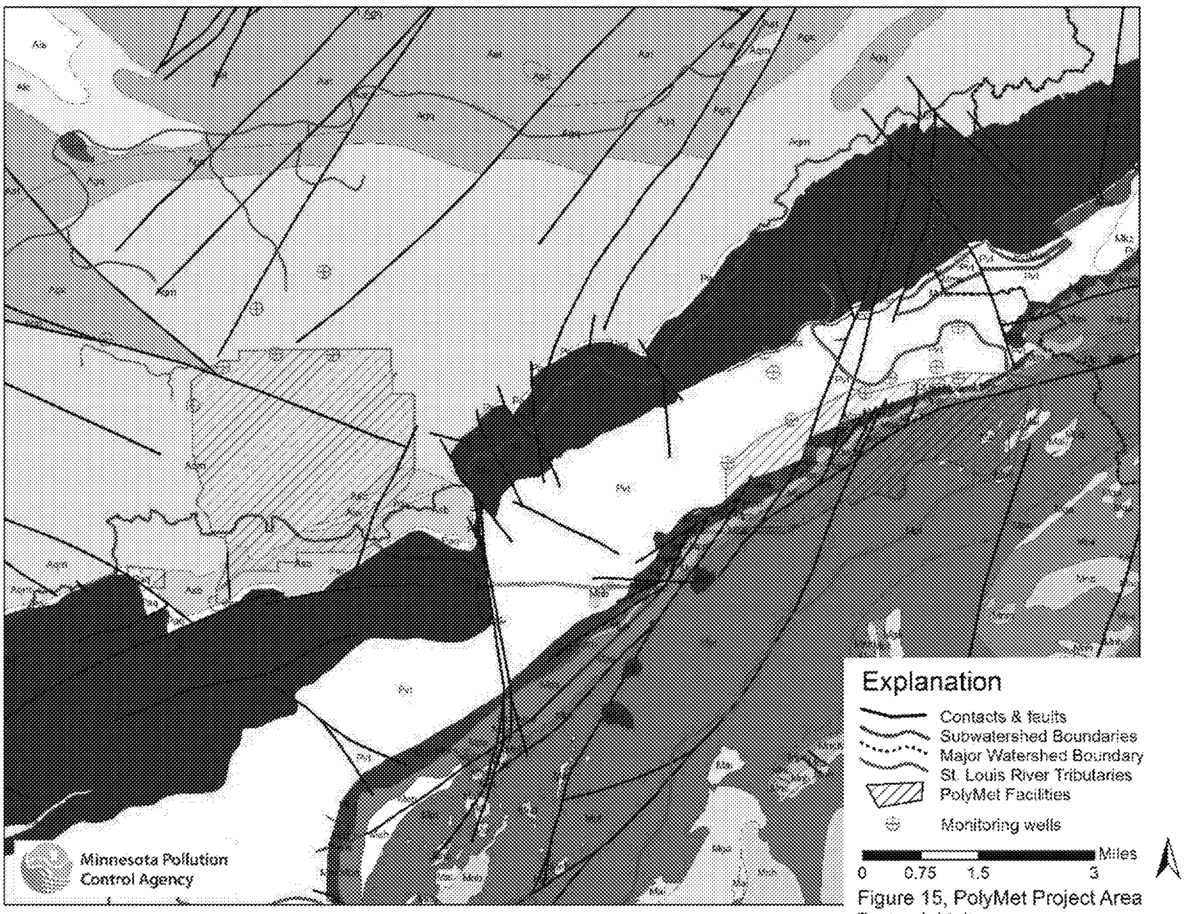


Figure 15, PolyMet Project Area Bedrock Units

Figure 15 shows the bedrock units as mapped by the MGS for the entire PolyMet process area. Contacts & faults, monitoring wells, and individual rock unit codes are included in this display (12). A full explanation of all rock unit codes can be found in the MGS Bedrock report (12). Included in the map are contacts and faults, the hatched outlines of the PolyMet facilities, and the locations of key monitoring wells, including those identified as bedrock wells at the Mine Site.

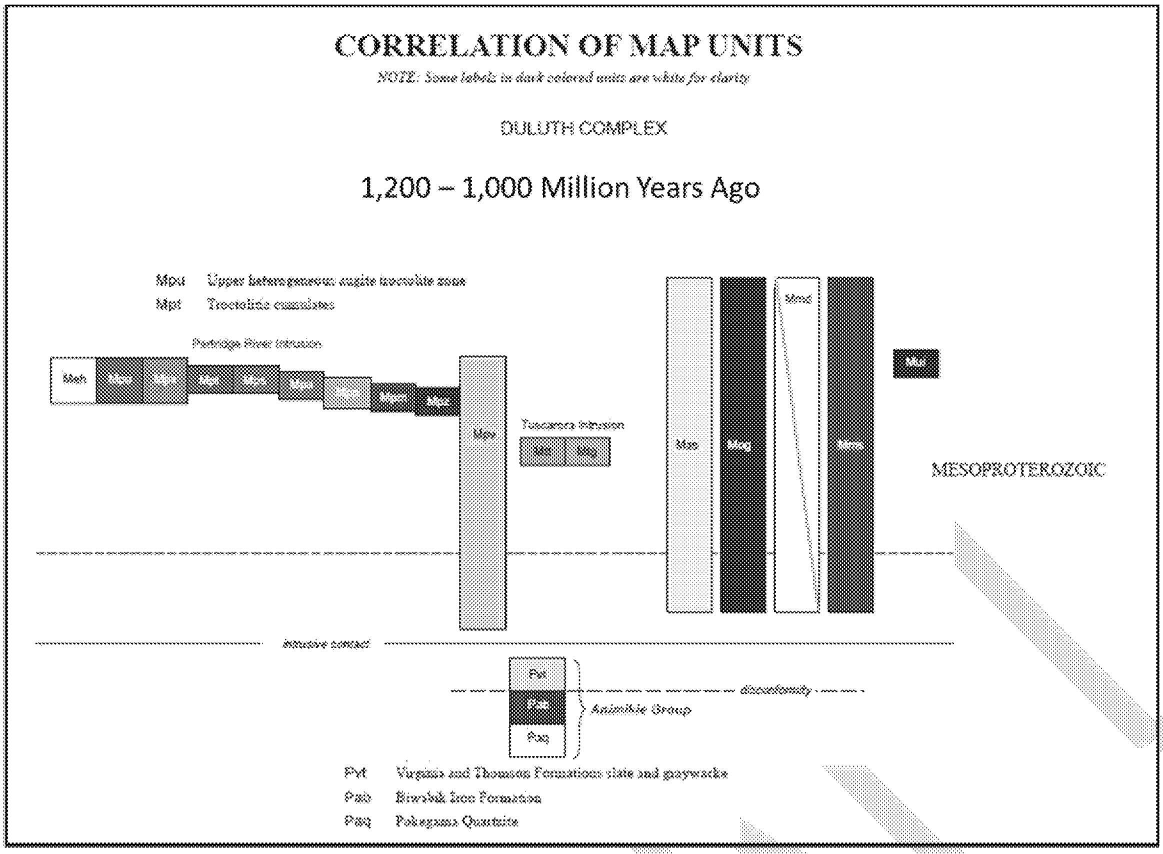


Figure 16, Minnesota's Bedrock Regions, Source MN Geological Survey

A small subset of relevant unit codes from Figure 15 are presented in Figure 16.

Further complicating the review of groundwater flow in the bedrock units, according to the MGS map authors in a personal communication, the location and length of each fault in Figure 15 is only an estimate:

> Th(e) level of accuracy at this map scale (plus or minus a hundred feet or more) is typical for even the best exposed bedrock areas.....(O)utcrop .... represents something less than 2% of the land surface in the arrowhead region. .... the best gauge of accuracy is the data density. Faults are rarely exposed, as they tend to weather recessively. If the mapped fault has outcrops on its flanks, it's pretty well constrained (but still possibly 100' or so accuracy). The fault in question is likely based on offset of units using drill core, then extended with some certainty using lidar or other more remote-sensed data--best that can be done with at this scale with the data at hand.

The location of the faults in this map cannot therefore be used to determine the presence of potential preferential pathways for groundwater, because too little is known of the actual location and orientation of the faults themselves.

D. Monitoring Well Review

Compliance monitoring of groundwater is defined in Volume 1, Section 3.1, page 32 of the PolyMet NPDES/SDS permit application (13) as:

> Compliance Monitoring (groundwater): Compliance monitoring will be conducted at locations where the Project will need to demonstrate compliance. These locations are downgradient of potential Project impacts. Groundwater compliance monitoring stations are typically at or near the property boundaries.

The compliance network of monitoring wells and their placement was therefore judged on their efficacy for intercepting potential contaminated groundwater released from the PolyMet facilities. Potential gaps in the coverage will be identified and new locations of monitoring wells proposed.

As discussed earlier, there are limited wells completed into the bedrock because any flow would be restricted to the small and unmapped fractures. This flow, where it exists at all, is assumed to be minor. Wells constructed to monitor possible bedrock flow are therefore screened at the top of the bedrock surface where they may be an interaction of groundwater flow from the surficial and bedrock geology.

The effectiveness of the placement of monitoring wells in the PolyMet application can be assessed by combining information from the previous slides on thickness, geologic make-up, and groundwater flow directions. Monitoring wells are placed to provide early detection of contaminated groundwater leaving one of the Mine site facilities. Generally, monitoring wells should be located between the facilities of concern and the surface discharge point for the local, surficial groundwater system. Where possible these wells should be placed into sand-dominated surficial geologic units because such units convey larger volumes of groundwater faster to surface water discharge points. These are pathways that are best suited for monitoring wells.

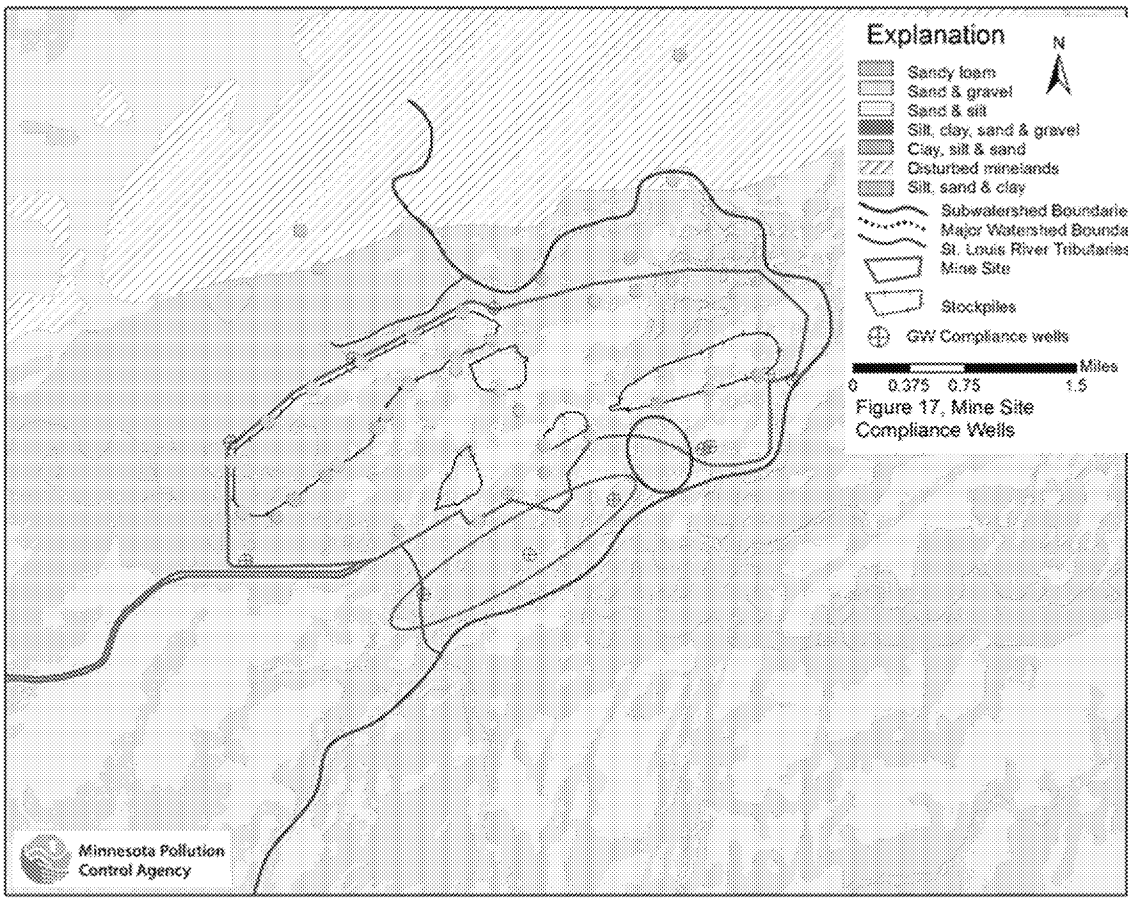


Figure 17 shows a close-up of the Mine site area with property boundary monitoring wells identified as blue crosses within circles. Other monitoring wells in the region are shown as lighter blue dots. A first observation is that while there are monitoring wells located within a half mile of the southern boundaries of the stockpiles, the three wells lying closest to the Partridge River south of the stockpiles are completed in clay-dominated geologic units, or are located upgradient of clay-dominated units (blue oval). Groundwater flow through clay-dominated materials is much slower than sand-dominated materials, and so wells completed along pathways dominated by clay are less likely to provide early warning of a release of contaminated groundwater. This would make reliance on such wells less desirable for use as compliance wells. Alternately, a sand-dominated expanse (red oval) that represents a preferential groundwater flowpath to the Partridge River is not monitored. A monitoring well to be located in this area has since been proposed by PolyMet and is expected to be included in the NPDES/SDS permit for the Project.

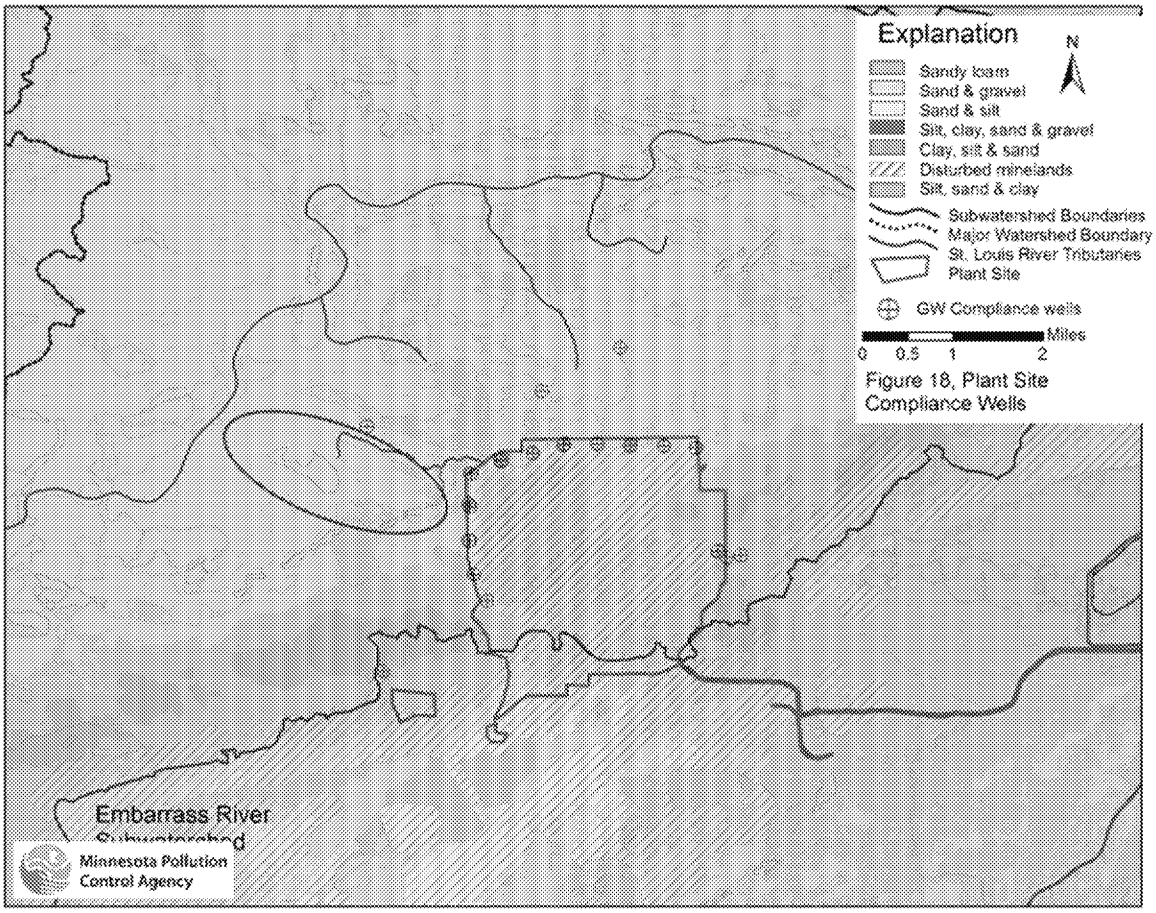


Figure 18, Plant Site Compliance Wells

It was determined earlier in the report that groundwater flows north across the former tailings basin toward the Embarrass River and its tributaries. Compliance wells displayed in Figure 18 should be evaluated for their ability to intersect groundwater flowing toward these streams. As with Figure 17, the three property boundary monitoring wells are represented by dark blue crosses inside of blue circles, while all other wells are shown as light blue dots. The LiDAR component of surface elevation is included to indicate with dark shading where surface elevations are highest, to indicate areas less likely to be a preferential flowpath. There is one compliance well to the northwest of the Plant site. According to the MGS geologic map, this well is located near the boundary between sand-dominated subsurface materials and clay-dominated geologic materials. If the well is constructed in clayey materials, the probability that it will effectively monitor Project groundwater impacts is reduced. The large area encompassed by the red oval that lies between Unnamed Creek and the highlands to the south is an area that could be considered for an additional monitoring well if a review of the existing well suggests that it is not an effective downgradient monitoring point (and assuming property ownership and access are amenable). Monitoring of the existing well and an annual assessment of its suitability is expected to be included in the NPDES/SDS permit for the Project. The two wells north of the tailings basin are completed in sand-dominated materials and appear to be appropriately located.

Any new wells installed to compliment the existing well network should be constructed as well nests. A nest can be as few as two wells in close areal proximity to each other. The deeper well's screen base should be set against the bedrock surface and should extend up-column 2 to 4 feet. The shallower well should be screened across the most permeable section of the aquifer as determined from the well log. This configuration will allow a higher probability of intercepting any contaminated groundwater flowing toward the Embarrass River and its tributaries.

E. Statistical Determination of a Groundwater Release

The PolyMet nondegradation application asserts that groundwater has a low probability of escape from the engineered containment systems that will be employed at the PolyMet project areas. In the case of the Mine Site this includes the temporary waste rock and ore stockpiles, the overburden storage and laydown area, the wastewater treatment system equalization basins, the mine pits, mine water sumps, and overflow ponds. The language used is (14):

> Each of the Mine Site features with the potential to affect groundwater will be constructed and managed to maintain natural groundwater quality to the maximum practicable extent.

And

> PolyMet will monitor the performance of the Mine Site engineering controls and the groundwater quality downgradient of Mine Site features (Section 3.2.1 of Volume I) to meet the maximum practicable extent requirements of Minnesota Rules, chapter 7060, and if the engineering controls are not achieving the desired outcomes, will implement adaptive management actions or contingency mitigation (Sections 6.5 and 6.6 of Reference (2)), as necessary to comply with all permit conditions. (NPDES/SDS Permit App – Vol II, Mine Site, section 4.4)

Also included is a table with predicted arrival times for contaminated groundwater for different elements of the Mine Site from the same volume (15):

Table 4-1 Estimated Flow from Potential Sources of Groundwater Impacts

Contaminant Source	Flow Rate (gpm)	Duration of Source (Mine Years)	Mine Year when Solute Plume First Arrives at Partridge River
East/Central Pit	3.75(1)	20+	100
West Pit	6.09(1)	48+	105
Category 2/3 Waste Rock Stockpile (Temporary)	0.0193	0-20	35
Ore Surge Pile (Temporary)	0.00116	0-21	90
Waste Water Treatment Facility (WWTF) Equalization Basins	0.0138	0-33	85
Overburden Storage and Laydown Area	14.0	0-20	30(2)

Information from Table 5.2.2-27 of Reference (8), based on GoldSim deterministic run with 50th percentile inputs. See Section 3.0 of Reference (4) for a description of the GoldSim modeling.

(1) Pit water into groundwater flow path

(2) Concentration decrease

Nonparametric Sign Test and Signed-Rank Test

The concept of 'solute plume' that is used in the table above can be assumed to refer to a concentration of a parameter or parameters related to sulfide deposits or other compounds related to the area parent rock that are found in groundwater, and is/are greater than the recorded values in wells before the beginning of mining. But how much greater? It is common in technical studies to answer this question with statistical tools that determine the point when a particular dataset differs in a statistically significant fashion from another dataset. For the PolyMet wells, the datasets would be water quality samples taken from wells before mining, and then again after the start of mining. The recommended statistical tests for such paired results (before and after) are the sign test and the signed-rank test. (16). The use of these tests are outlined in a hydrology handbook developed by the United States Geological Survey entitled, "Statistical Methods in Water Resources", by D.R. Helsel (17). Using the tests' procedures, the pairs of water quality results are compared for signs of differences, a check on the assumption that the engineering controls are achieving nondegradation of groundwater as predicted in the above table. These nonparametric tests are more appropriate to environmental data than parametric statistics that assume normally distributed datasets. The suggested p level employed would be $\alpha = 0.05$ significance level. Another way of saying this is that we want the probability that the difference between the datasets is not due to chance to be 95% or greater.

It is recommended that MPCA review of groundwater monitoring data incorporate appropriate statistical methodologies and that if the draft permit requires PolyMet to submit a periodic groundwater monitoring report, that it requires that report to describe the statistical tests that were employed.

F. Conclusions.

Groundwater flow in the surficial aquifer of the PolyMet project area is controlled by the geomorphology of the upper St. Louis River Watershed within which it is found. Groundwater sheds and surface watersheds coincide due to the presence of thin sequences of surficial material and the dense nature of the underlying bedrock. Groundwater flow in both aquifers, in both the Embarrass and Partridge River watersheds, is assumed to remain within each watershed before discharging to surface water.

There are several recommendations that can be made based on this technical review of the PolyMet application. The first is that there is a need for a new property boundary monitoring well(s) south of the Mine site, in the area shown in Figure 17. There are also areas downgradient of the Tailings Basin in the Embarrass River watershed that could similarly be covered with a new monitoring well if any existing wells are found to be ineffective, as shown in Figure 18. New wells should be placed in well nests, with a deep well screened above the bedrock/surficial geology interface, and a shallower well screened either across the water table or across the most permeable section of the aquifer if demonstrated to more appropriate.

A nonparametric statistical test such as the sign or the signed-rank could be employed to determine when post-mining water quality results differ from pre-mining concentrations to a statistically significant level. These recommendations are made to meet the requirements of the groundwater nondegradation policy as outlined in Minnesota Rule 7060.0500.

References

(1) Minnesota Rule 7050, surface water; https://www.revisor.mn.gov/rules/?id=7050

(2) Minnesota Rule 7060, groundwater; https://www.revisor.mn.gov/rules/?id=7060

(3) MPCA Surface Water Anti-degradation response; \\x1600\xdrive\Agency_Files\Mining Sector\NorthMet\Non-Deg\Anti-Degradation-11.docx

(4) PolyMet NPDES Permit Application, Volume 2, Table 1-2, page 18; https://www.pca.state.mn.us/sites/default/files/NPDES-SDS%20Permit%20App%20-%20Vol%20II%20-%20Mine%20Site%20v1%20JUL2016.pdf

(5) PolyMet NPDES Permit Application, Volume 5, Table 1-2, page 12: https://www.pca.state.mn.us/sites/default/files/NPDES-SDS%20Permit%20App%20-%20Vol%20V%20%E2%80%93%20Tailings%20Basin%20and%20Beneficiation%20Plant%20v1%20JUL2016.pdf

(6) MPCA site, Water Quality Permit for NorthMet; https://www.pca.state.mn.us/quick-links/water-quality-permit-northmet

(7) PolyMet NPDES Permit Application, Volume 5, Tables 3-4, 3-5, and 3-6; https://www.pca.state.mn.us/sites/default/files/NPDES-SDS%20Permit%20App%20-%20Vol%20V%20%E2%80%93%20Tailings%20Basin%20and%20Beneficiation%20Plant%20v1%20JUL2016.pdf

(8) PolyMet NPDES Permit Application, Volume 6, Large Figure #3; https://www.pca.state.mn.us/sites/default/files/NPDES-SDS%20Permit%20App%20Vol%20VI%E2%80%93HRF%20and%20Hydrometallurgical%20Plant%20v1%20JUL2016.pdf

(9) PolyMet NPDES Permit Application, Volume 2, Section 4.3.2; https://www.pca.state.mn.us/sites/default/files/NPDES-SDS%20Permit%20App%20-%20Vol%20II%20-%20Mine%20Site%20v1%20JUL2016.pdf

(10) Minnesota Geological Survey, surficial geologic map of the Central Arrowhead Area, Lake and St. Louis Counties, northeastern Minnesota; http://conservancy.umn.edu/bitstream/handle/11299/183258/SurfaceGeologyPlate.pdf?sequence=2&isAllowed=y, and (http://hdl.handle.net/11299/183258)

(11) Mineral potential and geology of Paleozoic and Mesozoic rocks in Minnesota, MGS Report: http://www.mngs.umn.edu/mnpot/paleozoic.html.

(12) Minnesota Geological Survey, bedrock geologic map of the Central Arrowhead Area, Lake and St. Louis Counties, northeastern Minnesota; http://conservancy.umn.edu/bitstream/handle/11299/183258/BedrockGeologyPlate.pdf?sequence=5&isAllowed=y

(13) PolyMet NPDES Permit Application, Volume 1, Section 3.1, page 32; https://www.pca.state.mn.us/sites/default/files/NPDES-SDS%20Permit%20App%20-%20Vol%20I%20%E2%80%93%20Introduction%20v1%20JUL2016.pdf

(14) PolyMet NPDES Permit Application, Volume 2, Section 4.4; https://www.pca.state.mn.us/sites/default/files/NPDES-SDS%20Permit%20App%20-%20Vol%20II%20-%20Mine%20Site%20v1%20JUL2016.pdf

(15) PolyMet NPDES Permit Application, Volume 2, Section 4.4, Table 4-1, page 52; https://www.pca.state.mn.us/sites/default/files/NPDES-SDS%20Permit%20App%20-%20Vol%20II%20-%20Mine%20Site%20v1%20JUL2016.pdf

(16) Statistical tests; https://en.wikipedia.org/wiki/Sign_test, https://en.wikipedia.org/wiki/Wilcoxon_signed-rank_test

(17) Statistical Methods in Water Resources, Chapter 6, Matched-pair Tests, page 137 (US Geological Survey); https://pubs.usgs.gov/twri/twri4a3/pdf/twri4a3-new.pdf

(18) Mapping resources from Minnesota Geospatial Commons, MPCA GIS Services, and Barr Engineering.

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ATTACHMENT 5 – Acronyms and Abbreviations

Acronym or Abbreviation	Description
Cliffs Erie	Cliffs Erie, LLC
CPS	Central Pumping Station
FTB	Flotation Tailings Basin
gpd	gallons per day
gpm	gallons per minute
HCEQ	High Concentration Equalization
HRF	Hydrometallurgical Residue Facility
LCEQ	Low Concentration Equalization
LTVSMC	LTV Steel Mining Company
MDNR	Minnesota Department of Natural Resources
MG	Million Gallons
mg/L	milligrams per liter
mgd	million gallons per day
MPCA	Minnesota Pollution Control Agency
MPP	Mine to Plant Pipelines
NF	Nanofiltration
ng/L	Nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
OIRW	Outstanding International Resource Water
ORVW	Outstanding Resource Value Water
OSLA	Overburden Storage and Laydown Area
OSP	Ore Surge Pile
P90	90^{th} Percentile
PGE	Platinum-Group Elements
PolyMet	Poly Met Mining, Inc.
Project	NorthMet Project
RO	Reverse Osmosis
RPE	Reasonable Potential to Exceed
RTH	Rail Transfer Hopper
SDS	State Disposal System
STS	Sewage Treatment System
SWPPP	Stormwater Pollution Prevention Plan
USEPA	U.S. Environmental Protection Agency
VSEP	Vibratory Sheer Enhanced Process
WWTS	Wastewater Treatment System